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THE GROSS EARNINGS OF 144 RAILWAYS, operating 87,714 miles of road, for the month of April are $37,239,473, according to *Bradstreet's*. This is an increase of 3.1% in mileage and of 4.4% in earnings, the smallest increase in earnings of any month of the present year. It is to be noted, however, that the increase for April, 1890, was the largest of any month but one of that year, being 13.7% over April, 1889. From the detailed figures it also appears that fewer roads show decreases, and that the increase as a whole is not so largely dependent upon large increases in one or two groups. Considering the roads by groups, the Southern roads lead, with a gain of 9.8%, and are followed by the Eastern and Pacific roads, with gains of 7.4% and 6% respectively. Other gains are the Southwestern roads, 5%, the Granger roads, 4.4%, and the Central Western roads, 1.6%. The Trunk lines show a decrease of 3%. Of the total number, 34 roads show decreases.

THE TOPOGRAPHICAL SURVEY OF CONNECTICUT, which has been in progress for some time under the direction of a State Commission appointed for that purpose, will be completed this month. The results of the survey will be published in 30 maps drawn to a scale of two miles to the inch. It is expected to have the drawing of the maps finished by July 1, 1892. Professor BREWER, of Yale, Chairman of the Commission, states that the maps will give the contours and show the swamps, roads, forests, country houses and the county and township lines. The importance of the maps may be judged from the fact that the size of the townships and counties is very vaguely known, while the area of the State cannot be estimated without liability to an error of several hundred square miles.

THE LAKE SHIPYARDS are building more ocean steamers. The steamship "Mackinaw" was launched from the yards of F. W. Wheeler & Co., at West Bay City, Mich., on May 2. The vessel was launched in two sections, and in that shape will be towed to Montreal, where the two parts will be joined together. It is necessary to build in this manner to pass the vessel through the locks of the Canadian canals. A steamer was built at these yards last summer and taken to the Atlantic; but she was launched whole and cut in two in a Buffalo dry dock for taking through the canals. Work is soon to begin at the Wheeler yards on a twin-screw steel steamer for the Nicaragua Canal Co.

THE BOYER RAILWAY SPEED RECORDER is being tested on the Connecticut River R. R. The machine consists of a small rotary pump, cylinder and piston, contained in a box over the rear axle of the forward truck. Oil circulates through the pump chambers and cylinder. While the machine is at rest, the piston, which carries a pencil, is held at its lowest position by two coil springs. When the axle revolves and turns the rotary pump, the oil is forced into the cylinder and the piston is forced up until equilibrium is established between the springs above and the oil below it. The instrument is adjusted so that a rise of $\frac{1}{32}$ in. indicates a speed of one mile an hour. Moving around a drum in the upper part of the machine at the rate of half an inch to each mile is a paper ribbon having horizontal and vertical lines, the horizontals being spaced at intervals representing speeds of 5 miles an hour and the verticals being spaced by intervals representing miles. The pencil traces a broken line on this paper from which the speed at any point may be approximately determined.

AN IMPORTANT RAILWAY CONCESSION has been obtained from the governments of Brazil and Bolivia by George Foster, of Milford, Pa., and John Hurd, of New York State. The concession is for the railway connecting those two countries, which was commenced about 15 years ago by Collins Bros., of Philadelphia, who abandoned the project owing to the failure of English capitalists to keep faith with them. The concession includes a tract of land 10 miles wide on each side of the road for its entire length. This land is covered with heavy forests of valuable timber. The line will give Bolivia a connection with navigation on the Amazon river.

THE WORST ACCIDENT OF THE WEEK was a rear collision May 18 between two freight trains on the Louisville & Nashville R. R., near Birmingham, Ala., resulting in the death of three men. The rear train was running at high speed down a grade, and the flagman of the head train did not go back far enough.——Another accident, in which two men were killed and three were badly injured, occurred on the Long Island R. R. at Greenville, May 17. A local train, consisting of an engine and one passenger coach, was derailed and went down a high embankment.

AN ACCIDENT OCCURRED in excavating for a sewer at Providence, R. I., May 19, causing the death of five persons. The trench which was being dug was about 26 ft. deep and 14 ft. wide, in loose soil, with some quicksand. A heavy mortar box rested on sills on top of the trench. These gave way, and the mortar box fell, knocking out the cross timbers by which the planking on the sides of the trench was held in place. The earth caved in, filling the trench about half full and burying several of the workmen.

TWO ATTEMPTS AT TRAIN WRECKING by placing obstructions on the track are reported, one near Columbus, Wis., on the Chicago, Milwaukee & St. Paul Ry., May 15, and the other near Whitings, N. J., on the New Jersey Southern R. R., May 20. In both cases the train was stopped with little damage.

A BRIDGE ACCIDENT occurred recently on the London, Brighton & South Coast Ry. in England near South Norwood Junction. A train was derailed while crossing a bridge, and the structure fell, not, however, until all the cars but the rear brake van had passed over it. The train stopped with this car hanging over the edge of the break left by the fallen bridge. The failure is stated by the superintendent of the road to have been due to a "latent flaw" in one of the bridge girders. Plans for a new structure to replace the bridge had been approved about three weeks before the accident; but it seems that action was delayed a little too long. We have been watching for details of the occurrence in the English technical journals, but have not seen any.

EXPERIMENTAL IRRIGATION STATIONS have been established by the government at Huron and Aberdeen, S. Dak. At the former place three reservoirs will be built to store water from artesian wells already sunk, and experiments will be made on about 20 acres of land in connection with each reservoir. Mr. B. S. LA GRANGE, of Colorado, will have direct charge of the stations, which are under the supervision of Mr. E. S. NETTLETON, Engineer of the Artesian and Underflow Investigation being carried on by the Department of Agriculture.

THE CASTLEWOOD DAM, near Denver, Col., has been declared faulty in construction by an investigating committee consisting of Messrs. H. F. MERRYWEATHER, DONALD CAMPBELL and J. P. MAXWELL. The committee think the dam, which is of masonry, can be made perfectly safe by carrying out the plan of Mr. A. P. BOLLER, of New York, Consulting Engineer for the Denver Water Storage Co., which owns the dam. An earth embankment has already been built on the water side of the dam, partly to the top. It is proposed to carry the embankment up to the end of the spillway, pave it and make other improvements. Further details regarding the dam were given in our issue of May 2, 1890, p. 413.

THE CABLE RAILWAY of the Baltimore Traction Co., at Baltimore, Md., is practically completed. It has about 6 miles of double track laid upon iron yokes placed five feet apart and weighing 500 lbs. each. The power-houses each contain two 500 H. P. Corliss engines, with driving drum 26 ft. in diameter. The power is transferred from the engine shaft to the driving drum by 32 cotton ropes 2½ ins. in diameter. A similar use of cotton ropes for belting is in practice on the cable railway recently put in operation at San Diego, Cal. (ENGINEERING NEWS, Nov. 22 and 29, 1890). The cars weigh 15,000 lbs. each and run on two trucks of four wheels each. The contract for the work was let to the United States Construction Co., of Philadelphia.

THE MEMPHIS BRIDGE work is making good progress. The masonry has been completed, pier No. 2 being finished April 25. The two trusses of the anchorage spans are erected, but have not been riveted up, and the floor beams and stringers are not yet in place. The pier posts are 77 ft. 7⅛ in. c. to c. of piers. The false work for the first cantilever west of pier No. 1 is up, and the ironwork will be put in place as soon as the material arrives. Work is now in progress on both the east and west approaches.

THE DYNAMITE-THROWER *Vesuvius* was tested for accuracy of fire near Fortress Monroe on May 18. Six shots were fired from the starboard gun at one mile, three-fourths and one-half mile range. Any one of these six shots would have struck a ship the size of the *Yorktown*, and one was a bull's-eye. The center gun was then tested to construct its curve, as it had not previously been ranged. These shots fell from 20 to 30 yds. short of the target; but the maximum force was satisfactory and the range uniform. The tests are being continued. The projectiles acted very well, with a uniform flight.

THE GULF OF MEXICO IS RISING, says Mr. JOHN SMYTH, in the New Orleans *Times-Democrat*. As proof of his assertion Mr. SMYTH says that the surveys of Col. W. S. CAMPSON, made about 50 years ago, show that a certain bench mark in the machine shop of the New Orleans & Carrollton R. R. was 8.2 ft. above mean tide in Lake Ponchartrain. The delta survey of 1851 made the difference in level of the same points 7.92 ft. The Mississippi River Commission survey of 1882 made it 7.13 ft. He argues from this that in the last 50 years the waters of the Gulf and Lake Ponchartrain have risen 1.07 ft. This is interesting if true, and like phenomena have been noted in the Adriatic and Mediterranean seas. But bench-marks are not particularly stable in the region about New Orleans; and the sinking of the ground about the machine shops, if proved, would just as easily explain the alleged difference in water level.

THE PROPOSED CANADIAN CANAL, to utilize the water power of Niagara Falls, is claimed to be simply a land deal, as there is no demand on that side for the enormous power undoubtedly available. As outlined, the scheme of an English-American syndicate is to cut a canal, 12 miles long, from the head of Chippewa Creek to an outlet above Queenston, on the Niagara River. The total fall would be about 200 ft., and the cost is estimated at $5,000,000. The serious drawback to the project is that the Welland Canal is only a few miles distant, and the waste water from that canal is said to represent daily a power of 40,000 to 60,000 HP., for which there is no demand and would be no charge.

Interlocking Plant at Jersey City Terminals of the New York, Lake Erie & Western R. R.

The accompanying engraving shows a plan of the new interlocking plant recently constructed by the Johnson Railroad Signal Co. for the Jersey City terminals of the New York, Lake Erie & Western R. R. The movements of all trains and engines are controlled from three signal-towers, one located at the west end of the train shed, one at Grove St., and one at Coles St.

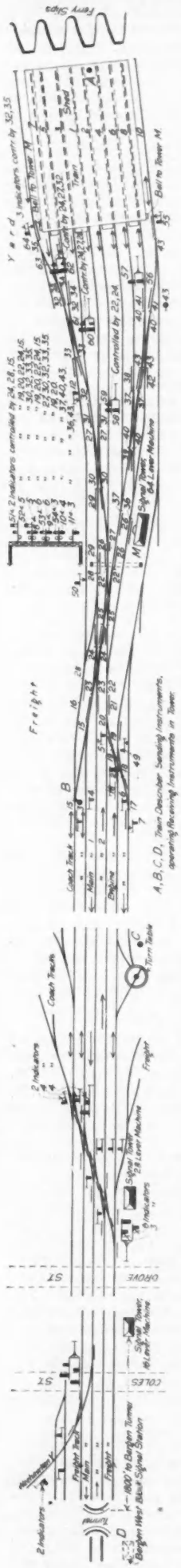
The foreman has control of all train movements, and the levermen work in accordance with his verbal instructions. This arrangement was considered advisable on account of the excessive congestion of traffic at certain times in the day. There are eight tracks in the train shed; and the departure of passenger trains from these tracks is governed by starting signals, mounted on continuations of the gate posts at the rear of the shed. These signals are operated from a tower, placed immediately above, and in easy communication with the Station Master's office. On the arrival of the last boats which are scheduled to connect with a particular train, from the up town and down-town ferries, the boat slips are deposited in the S ation Master's office, where they are signed and sent up to the signalman above by means of a small tube. On receipt of the slips, he notifies the main signal tower by the train describer that a train is ready to depart from a certain track. As soon as the acknowledgment is received from the main tower, the small arm at the end of the track is lowered to the clear position, which informs the train conductor that his train must depart. At the same time the gate is closed.

The only unique signaling is that on the signal bridge. The bridge is so placed that the signals thereon govern movements from any track to any track, going either east or west. By the use of selectors, all the bridge signals are operated by 8 levers. Without selectors, the bridge signals would have required 36 levers. All the appliances are those of the Johnson Railroad Signal Co. A noticeable feature was the absence of trouble through the catching of locking.

On account of the great number of train movements made between the hours of 8 A. M. and 10 A. M., and between 5 P. M. and 7 P. M., the levermen were given three weeks' instruction and practice, and three practice Sundays, working the traffic. All the men were taken from the yard, and had had no previous experience with interlocking.

The signal tower at the terminus was put into use on Sunday, May 3, at 10 A. M. On the opening day there was no delay whatever, but when the rush came on Monday morning, the men became somewhat confused, and so delayed a few trains. They caught up with the time-table by noon. The same thing occurred with the afternoon shift, but these men also caught up with the time-table by 7 P. M. On Tuesday morning there was a remarkable improvement in the speed with which the trains were handled, and no delay whatever took place. About 2 P. M. an accident occurred in Bergen tunnel, which completely stopped traffic both ways for three hours. There was naturally a rush when the tunnel was cleared, and Superintendent STEARNS said that the shed was cleared in quicker time than had ever been the case before, with the hand switches. Since that time there has been a gradual improvement, so that the company will soon find plenty of room in what was formerly a cramped train shed.

Mr. CHAS. R. JOHNSON and Messrs. HENRY and ARTHUR H. JOHNSON are the contractors' engineers. The frogs and switches were supplied by the Pennsylvania Steel Co.



INTERLOCKING AT JERSEY CITY TERMINUS OF THE NEW YORK, LAKE ERIE & WESTERN R. R. Johnson Railway Signal Co.

The main signal tower at the terminus contains a 64-lever Johnson interlocking machine. The Grove St. tower contains a 28-lever machine, and the Coles St. tower a 16-lever machine. The latter two towers are not yet in operation. It is the intention of the Railway Co. to connect three towers by the Sykes system and make them the stations for three additional block sections, thus extending the block system to the terminus. This will do away with the automatic banjo signals at present in use.

The main signal tower is operated by a foreman and two levermen on the night shift and a foreman and three levermen in each of the two day shifts. The foreman has a seat in the bay window, and his duty is to attend to the various audible and visual notices given on the "train describers," which connect with the Train Starter at *A*, the Yardmaster at *B*, the Engine Dispatcher at *C* and the block signal tower at Bergen West (*D*). He acknowledges each notice by two beats of the bell. The train describers are also connected by telephone, for use in cases of emergency. The train describers, telephones and bells are all conveniently located in the bay window.

Rapid Blue Printing Paper.

Mr. F. H. LATIMER, of Vancouver, B. C., writes us that a year or two ago, while experimenting with blue printing processes, more particularly with the object of getting bright blues and clear white lines, he found that after the usual washing a bath of quite dilute acid, such as hydrochloric, or, better, oxalic, would often greatly improve the clearness of the prints, a marked cause of dirty blues being a gradual altering of the solutions even when kept separate till just before using, though poor quality of the ammonio-citrate of iron seemed to have much to do with the results.

During the experiments he also found that an addition of oxalic acid to the ordinary blue print mixture materially lessened the time of necessary exposure. The solutions used were:

1. Ammonio-citrate of iron, 120 grains; water, 1 fluid ounce; to which is added a few drops of strong ammonia solution till the odor is quite perceptible.

2. Potassium ferricyanide, 105 grains; water, 1 fluid ounce.

3. Saturated solution of oxalic acid.

Equal quantities of (1) and (2) are taken (*a*); and after being mixed (3) is added as required and the mixture used at once.

Taking, say, in the proportion of 10 ounces of the mixture (*a*) and adding thereto (*b*) one ounce; (*c*) two ounces; or (*d*) three ounces of (3), the relative rapidity of the coated papers will be closely, in very dull light, as 1 : 2½ : 5 : 10, (*d*) paper being thus about 10 times as rapid printing as (*a*) in the light mentioned. For example, a print was made from a tracing on linen in 35 minutes on Feb. 25, 11.30 A. M., on (*d*) paper during a snow-storm, the light being quite dull, while ordinary paper takes the greater part of a day in an equal light.

This great difference only holds good in dark, cloudy weather; as, if comparisons are made in direct sunlight, (*d*) paper is only three to four times as rapid as (*a*). An explanation of this probably is, that a weak light that will reduce the oxalic acid mixture (partly ferric oxalate) has but a faint starting or continuing action on the ferric citrate, while with a strong light both commence at once.

For all ordinary purposes it is better not to use a greater percentage than 20% (*c*) of the oxalic acid solution, as it is difficult to get the lines to wash white with a higher percentage, even with thick black lines on the tracing or negative; and the more sensitive the paper the shorter time it will keep good even in the dark, and also the greater care required in its preparation and use. Some hard close grained paper that does not absorb much of the iron solution, such as parchment paper (Dietzgen & Co.), Mr. LATIMER has found to give the best results in this process, as, indeed, for all blue print work. To get the clearest prints the paper is better prepared a short time before using in a dark room by gas or lamp light or very weak sunlight.

Ferric oxalate and potassium ferricyanide mixed makes a very rapid printing paper, and can be made considerably cheaper than with the ferric citrate; but it is too sensitive for ordinary work, and requires more care than can be given to it in engineering work, as a rule. Ferric chloride is also more rapid and cheaper, but has the same disadvantages. They seem also to wash off the paper more than the citrate, though different sizing of the paper might remedy this. The only way to get white lines with the two latter, Mr. LATIMER has found, is to make the ferric salts frequently, so as to have them fresh, keeping the solutions in the dark or deep red light only.

These notes seem to be of highly practical nature, and we think those with much blue printing to do will do well to test them.

A Folding-Floor Drawbridge.

The novel drawbridge illustrated in the accompanying engraving has recently been completed over the Chicago River at Weed St., Chicago, Ill., under the supervision of the city engineer, and it was tested and opened for traffic on April 18.

The width of the river between dock lines at Weed St. is 150 ft., and the clear opening left for vessels by the new draw is 62 ft. As seen by the drawings, each half of the bridge consists of two riveted towers, from the top of which are suspended by tie-rods the two leaves of the floor. These are hinged together at their point of junction, and when the draw is to be opened this point rises, the ends of the leaves move downward, and the floor assumes the position shown by dotted lines in Fig. 1, and in the perspective view, Fig. 3. In this position not only is the space between the piers free for the passage of vessels, but the raised floors form effective guard gates.

To minimize the power required to raise the leaves, a counterweight is suspended on each tower. The wire rope from this counterweight passes over the pulley *P*, then around the cam *C*, and is made fast to it. On the same shaft with the cam *C* is a drum *D*. A wire rope made fast to this drum runs ove

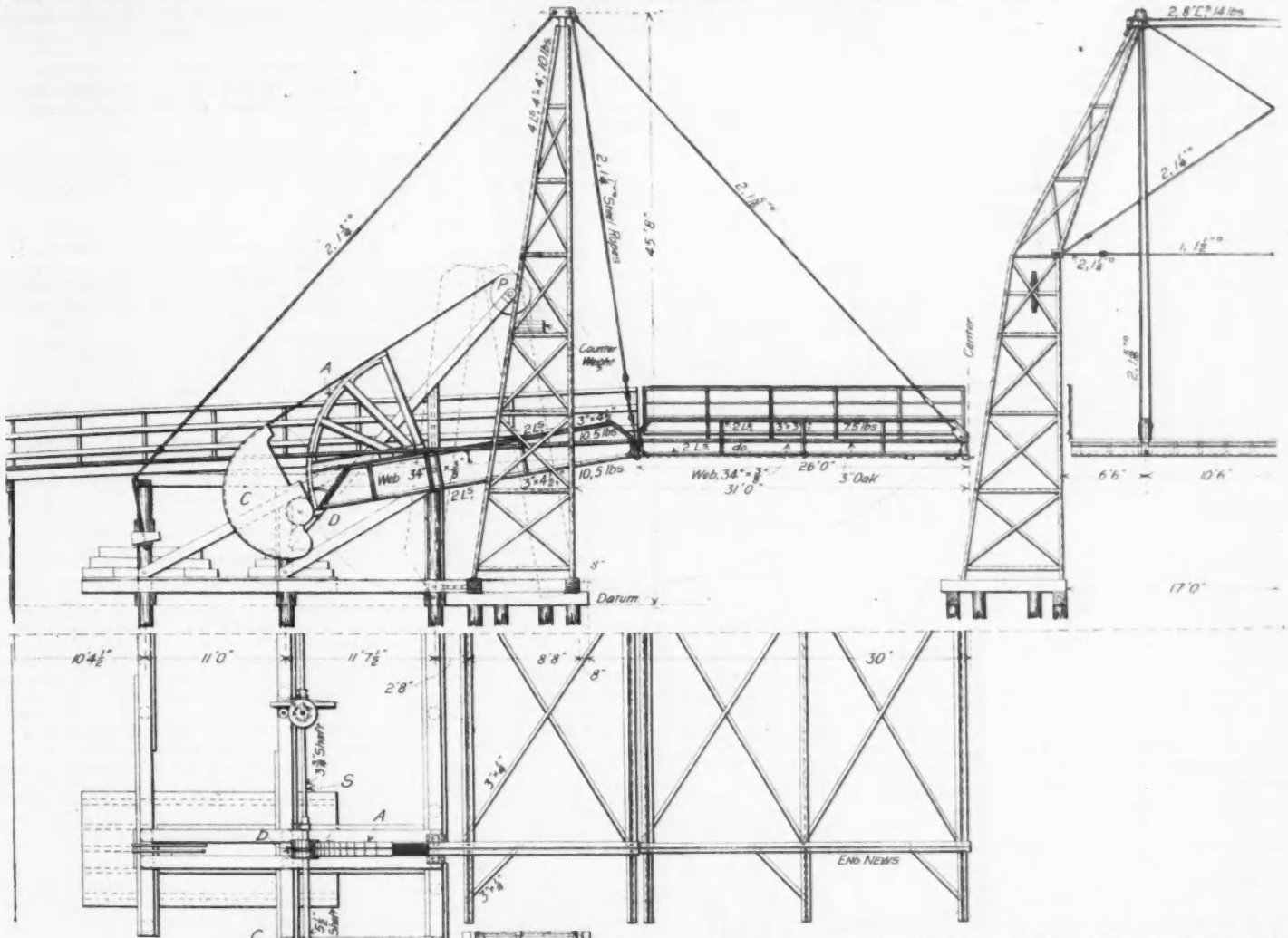


FIG. 1. FOLDING-FLOOR DRAWBRIDGE OVER THE CHICAGO RIVER AT WEED ST., CHICAGO, ILL. Shailer & Schniglau Engineers.

FIG. 2. DRAWBRIDGE CLOSED.

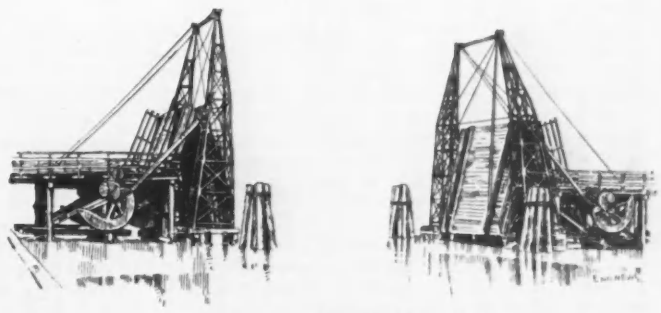


FIG. 3. DRAWBRIDGE OPEN.

the arc *A*, which forms part of the rear leaf of the floor. The resistance of the bridge to raising is greatest at the start and diminishes nearly to zero at the end of the movement. The cam enables the counterweight to offset this variable resistance by giving it a variable leverage on the drum which lifts the floor, greatest at the start and diminishing to zero at the close.

The power to raise and lower the bridge is applied to the shaft *S*, on which the drum is keyed, by means of gearing, and a sufficient leverage is thus obtained to enable one man to readily manage each half of the span.

The advantages claimed for this bridge over a pivot span are that it affords a clear passageway in the center of the stream, where the water is deepest, and there is no danger of the bridge being fouled by a vessel in swinging around. It is also said to be cheaper in construction (the cost of the Weed St. span is given as $16,000), and the cost of operation is small, as no engine is required, and each half span can be easily moved by one man. This peculiar type of bridge is the invention of Mr. WM. HARMAN, manager of the Chicago Towing Co. The engineers and contractors for the Weed St. structure were Messrs. Shailer & Schniglau, who have control of the invention. It is stated that another bridge of this type will be built this year across the Chicago River at Fourteenth St.

The Relative Economy of Cable, Electric and Animal Motive Power for Street Railways.

Census Bulletin No. 55, prepared by Mr. CHARLES H. COOLEY, under the supervison of Mr. HENRY C. ADAMS, special agent for transportation, gives the most complete information yet extant upon the question of the relative economy of cable, electric and animal motive power for street railways, a question of present importance in nearly every city in the country. Although it is still too early to form a final judgment regarding the value of electric motive power for this purpose, yet the statistics presented being, as they are, a record of actual experience, are likely to throw considerable light upon the matter. We therefore abstract it very fully, as follows:

As yet no data exist from which it is possible to form a final judgment regarding the value of the several motive powers now in use for the transportation of passengers in cities. Electric motive power, upon which both popular and technical interest is at this time concentrated, has a history in this country of only about six years, and, notwithstanding its brilliant achievement, can as yet be in but an early stage of development. The fact that over one-fourth of the street railway companies in the United States are already operating wholly or in part by electricity only indicates how great is to be the importance of this as yet indeterminate factor.

Not only is there an actual lack of data from which a final judgment can be formed, but such information as exists is in a form but imperfectly adopted for statistical treatment. In street railways, of whatever kind, no such approach to a uniform plan of accounts has been made as in the case of steam railways. In the particular case of

STATISTICS OF 10 STREET RAILWAY LINES OPERATED BY CABLES, 10 OPERATED BY ELECTRICITY AND 30 OPERATED BY HORSES.

(From Census Bulletin No. 55.

A.—10 Cable Railways.—1. Description and Cost.

No.	Length, miles. Of line.	Length, miles. Of tracks, including sidings.	Steepest grade. P. c.	Steepest grade. Length in feet.	Number of cars. Grip.	Number of cars. Trail.	Number of cars. Av. No. used at once.	H. P.	Total cost of road and equipment.
Total.	75.22	142.92	.....	.....	621	832	583	13,300	$26,351,417
1	8.50	17.00	20.0	1,300	116	380	118	1,450	$5,812,694
2	5.75	11.50	10.4	412	65	76	50	570	1,467,000
3	5.50	11.00	70.0	500	46	10	32	1,175	2,686,587
4	3.20	6.40	4.0	2,250	26	47	40	1,500	1,219,616
5	11.69	23.38	13.9	568	76	141	106	3,400	4,028,735
6	10.15	20.40	18.5	1,000	71	119	77	1,300	2,649,796
7	8.86	10.10	80.0	413	58	8	48	425	1,510,496
8	8.57	17.15	4.0	1,600	81	.....	36	1,250	2,257,860
9	2.72	5.44	2.1	200	12	.....	10	200	433,698
10	10.28	20.55	15.5	150	50	51	66	2,100	4,343,595

2. Statistics of Operation.

No.	Car mileage.	Number of Passengers Carried. Total.	Per mile operated.	Operating Expenses. Total.	Per car mile (cts.).	Per passenger carried (cts.).
Total.	23,272,654	101,995,695	1,355,965	$3,286,462	14.12	3.22
1	6,290,172	36,218,807	4,291,036	$1,063,835	16.91	2.94
2	1,653,303	10,030,491	1,744,433	355,415	21.50	3.54
3	1,413,280	8,229,909	1,496,729	200,694	14.16	2.43
4	1,404,000	4,697,587	1,439,871	145,299	10.35	3.15
5	4,696,120	12,602,044	1,083,152	441,152	9.39	3.48
6	3,355,435	9,506,979	936,550	344,290	10.26	3.62
7	1,744,750	8,113,655	915,762	271,721	21.91	3.36
8	1,595,650	6,781,083	791,328	225,069	14.11	3.32
9	310,331	1,346,825	495,154	57,698	18.59	4.28
10	1,307,613	4,498,820	437,628	180,949	13.84	4.02

B.—10 Electric Railways.—1. Description and Cost.

No.	Length, miles. Of line.	Length, miles. Of tracks, including sidings.	Steepest grade. P. c.	Steepest grade. Length in feet.	Number of cars. Motor.	Number of cars. Tow.	Number of cars. Av. No. used at once.	Total cost of road and equipment.
Total.	55.56	67.22	.....	.....	118	34	77	$1,788,278
1	11.71	16.35	12.50	7,920	47	.....	15	$374,720
2	4.11	7.54	5.20	475	12	.....	4	3,063,588
3	5.00	5.22	6.50	1,200	12	.....	6	2,779,369
4	10.00	12.13	8.00	800	21	.....	11	4,961,347
5	6.00	6.36	6.00	500	7	4	.....	1,442,617
6	3.00	3.25	7.50	300	4	.....	.....	49,000
7	4.25	4.50	4.00	500	6	.....	.....	184,755
8	2.80	2.80	6.50	250	3	2	.....	383,455
9	4.25	4.50	3.00	300	4	3	.....	293,536
10	4.44	4.56	7.00	300	2	.....	.....	1,622,949

2. Statistics of Operation.

No.	Car mileage.	Number of Passengers Carried. Total.	Per mile operated. For period covered.	Per year.	Operating Expenses. Total.	Per car mile (cts.).	Per passenger carried (cts.).
Total.	2,442,106	8,031,214	.....	.....	a222,648	$32 16	3.67
1	702,720	2,732,382	235,045	470,090	$46,775	21.48	3.17
2	317,655	828,756	201,157	248,047	25,82	23.68	3.26
3	257,793	1,041,978	208,396	208,396	23.68	18.46	3.62
4	634,000	1,690,000	168,000	168,000	18,46	18.28	3.77
5	92,400	465,713	77,619	155,238	18.28	3 26	3 26
6	85,668	323,244	107,748	107,748	292,002	19.53	3.26
7	186,400	400,000	94,118	94 118	288,599	17 32	3.94
8	71,375	221,415	79,077	79,077	229,074	23 02	4.67
9	74,340	259,509	61,061	61,061	32,570	25 79	3.89
10	19,754	60,217	14,795	.....	119,155	11 04	4.94

a See explanation of these figures in text.

C.—30 Railways Operated by Animal Power.—1. Description and Cost.

No.	Length. Number.	Length. Length of street length (miles).	Length. Length of all tracks, including sidings (miles).	Number of cars. Total.	Number of cars. Av. No. used at once.	Total cost of road and equipment.
Total.....	319.22	552.43	3,398	1,494	$22,788,278	
1		7.90	14.00	115	66	$374,720
2		7.92	23.15	181	76	3,063,588
3		9.38	19.16	196	110	2,779,369
4		78.35	164.25	1,509	500	4,961,347
5		22.50	46.75	166	117	1,442,617
6		11.40	21.35	218	88	2,197,774
7		11.00	23.04	204	82	571,273
8		8.00	16.00	60	24	384,500
9		1.57	3.14	10	6	331,300
10		5.12	10.25	67	34	320,004
11		8.00	13 00	65	30	281,394
12		6.27	10.90	57	26	414,257
13		7.83	17.00	57	30	418,533
14		4.79	4.94	23	17	221,739
15		6.48	12.96	33	20	169,318
16		2.50	2.75	9	6	49,000
17		6.50	6.50	27	25	184,755
18		13.34	16.13	72	30	383,455
19		11.31	14.60	51	25	293,536
20		29.25	45.00	90	73	1,622,949
21		12 17	12.94	55	21	290,411
22		4.17	5.00	20	11	96,000
23		4.35	4.83	13	7	69,679
24		12.75	13.50	39	17	313,333
25		5.03	5.38	18	7	100,300
26		5.90	6.60	18	6	82,315
27		1.88	1.94	6	5	64,361
28		4.50	6.34	13	9	70,472
29		3.37	4.34	13	8	51,591
30		6.30	6.69	13	8	93,699

2. Statistics of Operation.

No.	Car mileage.	Number of Passengers Carried. Total.	Per mile operated.	Operating Expenses. Total.	Per car mile (cts.).	Per passenger carried (cts.).
Total.	38,466,414	190,434,783	595,563	$6,986,020	18 16	3.67
1	2,168,100	14,698,551	2,088,364	$465,775	21.48	3.17
2	1,973,8.7	15,609,986	1,970,859	503,496	25.82	3.26
3	2,356,567	15,432,194	1,610,876	557,912	23.68	3.62
4	13,570,000	66,500,000	848,756	2,505,536	18.46	3.77
5	3,373,628	18,925,520	841,134	616,566	18.28	3 26
6	1,494,962	8,954,675	785,498	292,002	19.53	3.26
7	1,696,490	7,327,220	666,705	288,599	17 32	3.94
8	905,000	4,990,000	612,500	229,074	23 02	4.67
9	126,276	898,086	333,813	32,570	25 79	3.89
10	1,189,416	2,613,976	510,542	119,155	11 04	4.94
11	925,640	3,745,271	468 159	186,909	20.19	4.99
12	851,017	2,245,293	338 101	78,308	9 21	3.49
13	695,620	2,714,536	350,515	99,480	14.30	3.62
14	417,560	1,366,203	285,220	55,859	13 38	4.09
15	737,837	1,793,806	276,822	70,963	9 60	3.95
16	162,240	677,070	270,828	18,167	11.20	2.68
17	632,340	1,723,420	265,142	57,554	9.10	3.34
18	538,829	3,295,116	242,512	112,199	20.83	3.47
19	432,603	2,728,385	241,785	108,667	25.12	3.98
20	2,305,146	5,8.4,314	199,129	224,523	9.74	3.85
21	536,213	2,287,064	187,928	103,742	19 35	4.54
22	121,180	754,963	181,051	32,589	26.89	4.32
23	178,798	711,805	163,633	24,537	13.89	3.49
24	342,513	1,951,197	153,035	66,093	19.30	3.39
25	132,822	650,692	129,302	30,828	23.30	4.74
26	125,182	693,419	117,329	26,392	21.48	3.88
27	40,000	214,069	113,862	10,807	27.02	5.05
28	197,100	500,040	111,111	18,243	9 26	3.65
29	74,460	288,015	85,464	8,742	11.74	3.04
30	126,338	509,143	30,816	23,912	18.93	4.70

electric railways the obtaining of information from which a comparison may be made between these railways and others is beset with peculiar difficulties. The electric railways being nearly all new, the period of new construction has in few or no cases entirely ceased and been succeeded by that of regular and uniform operation. Again, most of the electric railways are the successors of roads operated by horses, and this latter motive power is in very many cases still retained on a part of the lines, the expenses incurred being intermixed with those incurred for electric power. It is plain that in all cases where more than one kind of motive power is used and no separate account of expenditure is kept the statistics are worthless for a comparison of the relative economy of the several kinds.

The statistics presented in this bulletin will not therefore form a basis for a final judgment regarding the relative economy of the various kinds of motive power, nor are the data concerning electric railways such that any certain deductions regarding the future performance of electricity can be drawn from them.

The facts presented are, however, a record of actual experience, and as such are believed to have considerable value notwithstanding the unsatisfactory character of some of the conditions attending that experience. The value of the information here given is to be looked for, not so much in an attempt to establish general propositions regarding the various motive powers, as in a careful scrutiny of the facts pertaining to each road, and especially of the detailed classification of operating expenses given in Table II. (not reproduced).

Plan of the Bulletin.—This bulletin embraces statistics of 50 lines of street railway, 10 of which are operated by cable, 10 by electricity and 30 by animal power. The following tab'e gives for each of the 50 roads a tabulated statement of a variety of facts which are of interest in connection with the question of economy in operation. A second and fuller table presents a detailed analysis of operating expenses.

In both tables the roads are arranged in an order determined by the density of traffic shown by their operating statistics. The road placed first is, in each case, the one carrying the greatest number of passengers per mile of line per year. This number, in the case of roads which have been operating for a whole year, is obtained by dividing the total number of passengers carried by the length of line. Where the statistics given covered less than a year (as they did for 4 of the electric railways only, none less than 6 months) the number carried per year is estimated at the same rate as for the fraction of a year given and the total divided by the length, as before.

Of the 10 electric railways for which statistics are given, the first 9 are operated by the system of overhead trolleys and the tenth by accumulators or storage batteries. It will be noticed that this last road operates but one car, and it may be presumed, therefore, that its operation is in some degree experimental. Great confidence in the success of this mode of operation is felt by those best acquainted with it, and it would be unwise to draw contrary conclusions from data so limited as are here presented.

In one case a single road, using all three kinds of motive power, is represented in each of the three divisions of the tables. This road is number 5 of cable railways, number 2 of electric railways and number 12 of railways operated by animal power.

A brief inspection of this table suggests at once that the statistics of the operation of electric railways are those of

an operation less settled and uniform than that of either cable or horse railways. The dates upon which each of the 20 cable and electric railways commenced operation are as follows:

Cable Railways.	Electric Railways.
No. 1. March 26, 1888.	No. 1. Jan. 17, 1890.
No. 2. March —, 1877.	No. 2. Sept. 8, 1889.
No. 3. Oct. —, 1888.	No. 3. Aug. 15. 1888.
No. 4. April 15, 1886.	No. 4. Nov. 3. 1888.
No. 5. May 1, 1887.	No. 5. April 5, 1890.
No. 6. June 26, 1885.	No. 6. May 1, 1888.
No. 7. March 28, 1888.	No. 7. Dec. 6. 1889.
No. 8. Sept. 15, 1887.	No. 8 July 20, 1889.
No. 9. Sept. —, 1886.	No. 9. Nov. 1, 1888.
No. 10. Aug. 22, 1889.	No. 10. Oct. 31, 1889.

The columns giving the operating expense per car mile and per passenger carried also show by the greater variations they exhibit in the case of electric railways that the statistics of these railways are less uniform than those of the animal and cable lines. For example; the expense per car mile of operating electric cars is seen to vary from 8.34 to 36.04 cts., the latter being over four times the former. In the case of cable railways the variation is from 9.39 cts. per car mile to 21.91 cts., or but little more than 100%. For railways operated by animal power the variation is from 9.10 to 27.02 cts.

The cost of operation per car mile is probably the best unit available for the purpose of comparisons relative to the economy of various kinds of motive power, and corresponds quite closely to the cost per train mile used for like comparisons in the discussion of statistics of steam railways. The cost per passenger carried is also important, since in the case of street railways the revenue varies directly for the most part with the number of passengers carried.

It should be remembered, however, that the result of such comparisons must be received with caution, especially as regards electric railways. Bearing this reservation in mind, the following comparative statement will be found of interest:

Items.	Cable railways. (Cents.)	Electric railways. (Cents.)	Railways operated by animal power. (Cents.)
Operating expense *per car mile*.....	14.12	13.21	18.16
Operating expense *per passenger carried*.....	3.22	5.82	3.67
Number of passengers carried per car mile.....	4.38	3.46	4.95

As the tenth electric road is operated under a different system from the others and presents quite peculiar features, the calculations by which these figures are obtained are based upon the statistics of the nine roads operated by the overhead system.

In so far as the operating expense per car mile is an index of economy in operation both cable and electric railways show a considerably greater economy than railways operated by animal power. It is noticeable, however, that electric railways, which have the least expense per car mile, have the greatest expense per passenger carried. In order to show the cause of this a statement of the ratio between passengers carried and car mileage is given, from which it appears that electric railways show a less number of passengers per car mile than either of the other classes.

The explanation of the fact here shown is doubtless that the electric roads, being new, occupy lines over which the passenger traffic has been but partly developed.

The expense per car mile and per passenger cannot profitably be considered without reference to other statistics, of which the most important, perhaps, are the first cost of road and equipment and the volume of passenger traffic carried on by means of it.

The following statement shows for each class of roads the total cost of road and equipment per mile of line and the number of passengers carried per mile per year:

Items.	Cable railways.	Electric railways.	Railways operated by animal power.
Total cost of road and equipment per mile of line (street length).....	$350,325	$46,698	$71,387
Number of passengers carried per mile per year.....	1,355,965	223,648	536,563

From this statement it is seen that the cable railways under consideration were built at a cost per mile of street occupied of over *seven* times as much as were the electric railways. The density of passenger traffic is about *six* times as great upon the cable as upon the electric railways. These figures correspond to the generally accepted fact that cable railways attain their greatest efficiency where an extremely heavy traffic is to be handled. As regards these items, the railways operated by animal power hold an intermediate position, showing a cost and a density of traffic somewhat greater than the electric railways, but much less than that of cable railways. Of course this does not indicate that under similar conditions an electric line is less expensive to build and equip than a line operated by horses, but simply that among the roads whose statistics are included in this exhibit the electric lines are of a less expensive class than the horse lines. The latter include a number of the largest and most expensively equipped lines in the country.

A comparison between the economy of the cable and electric roads represented cannot fairly be made without taking into consideration the fixed expenditure due to the greater first cost of the cable roads. However, a consideration of this item will not make so much difference as might at first be supposed, owing to the fact that the cable railways do a business nearly as large in proportion to their cost as do the electric railways. Calculating the fixed charge due to first cost at an assumed rate of 6%, and assigning this fixed charge to car mileage and passengers, we have the following results, in cents:

	Cable railways.	Electric railways.	Railways operated by animal power.
Operating expense per car mile.....	14.12	13.21	18.16
Interest charge per car mile at assumed rate of 6%.....	6.79	4.35	3.55
Sum of operating expense and interest.....	20.91	17..6	21.71
Operating expense per passenger carried.....	3.22	3.82	3.67
Interest charge per passonger at assumed rate of 6%.....	1.55	1.26	0.72
Sum of operating expense and interest.....	4.77	5.08	4.39

First Cost Relatively to Car Miles.

Animal, 3.55, or if the cost of horse lines is taken as the unit..... 1.00 ct.
Electric, 4.35, or if the cost of horse lines is taken as the unit..... 1.23 cts.
Cable, 6.79, or if the cost of horse lines is taken as the unit..... 1.91 cts.

First Cost Relatively to Passengers Carried.

Animal, 0.72, or, if we take cost of horse lines as the unit..... 1.00 cts.
Electric, 1.26, or, if we take cost of horse lines as the unit..... 1,75 cts.
Cable, 1.55, or, if we take cost of horse lines as the unit..... 2.15 cts.

These figures show, as nearly as can be shown from the statistics at hand, the relation between the first cost of lines operated by the several kinds of motive power and the amount of traffic which the road and equipment purchased at this cost will handle.

From the two columns giving the length of line it appears that the cable railways are for the most part laid with double track throughout their whole length. The only marked exception is No 7, in which the total length of all tracks is a little over a mile greater than the length of street occupied. It would seem, however, that the electric railways included in the table are none of them laid with double track throughout their whole length, Nos. 1 and 2 being the only ones whose track length is greatly in excess of the length of street occupied. The inference from this would seem to be that electric railways are being laid with double tracks only in thickly populated places, where dense traffic is expected. Many of the single-track electric railways are circuit lines; that is, those so arranged that the cars return to their starting point without going back over the same track. The single-track road does not necessarily involve turn-outs.

The columns giving per cent. and length of grades emphasize the well-understood superiority of cable railways upon the steepest grades. The steepest grade given for electric railways is 12.50%. Five of the cable railways have steeper grades than this, and the steepest of all rises for a distance of 413 ft. at an angle of over 35° with the horizontal.

Of the electric roads, Nos. 5, 8 and 9 rent their power, and the sum entered under the head of "current expenses for power" is in these cases the rental paid.

We have briefly commented on these valuable statistics in another column.

Improvements at the University of Pennsylvania.

In the improvements in contemplation at the University of Pennsylvania, the plans for which are now under way, two of the needs of the University which have lately made themselves strongly felt will be provided for.

One is the necessity of improving the heating and ventilation of existing buildings and providing for that of new buildings either in process of construction or to be erected in the immediate future. The other is the need of providing for the growing demands of the Department of Mechanical Engineering. This department, which was established 16 years ago, grew slowly, though steadily, until within the past three years, when the number of students began to increase rapidly. Additional facilities were provided, but in the last year the number has still further increased, and the department has found itself greatly hampered for lack of room.

The trustees have determined to meet both of these needs at the same time. Heretofore each building has been heated by a separate plant in its basement, and has been lighted by gas. It has been decided to build a central heating station, with a present boiler capacity of 1,200 HP., from which to heat all the buildings, at present 11 in number. In addition, the buildings are to be lighted throughout by electricity and to be thoroughly ventilated by the use of large ventilating fans in the basement, which are to be driven by steam or electric motors; while the ventilating flues in the old buildings are to be served for the purpose of instruction, for which it will at all times be available.

The boiler-house will be 100 × 50 ft., one story high, furnished with a stack of sufficient size for a plant of 1,200 HP. The provision for coal bins, ash vaults and weighing scales will be made in the most complete and convenient manner for the purposes of testing and instruction. The boiler plant will contain examples of the Galloway, return tubular, marine, and sectional boilers, ample in capacity for heating the present buildings, as well as the new Hygiene building, now under construction, and the large dormitory or apartment house about to be erected. Steam will be generated at 100 lbs., used in the engines, and, when exhausted, will be used for heating, so that the power used in generating electricity for lighting will be obtained at a minimum of cost, and the lighting of the buildings will be very much better than at present. Owing to the configuration of the land, it is possible to get a gravity return of the water from the condensed steam from all the separate buildings to a well in the boiler-house, from which it will be pumped into the boilers. The piping between the central station and the several structures will be on the Holly system.

Separated from the boiler-house by a distance of 15 ft. is the building for the Mechanical Engineering department, which will contain in its basement the engine and dynamo room. This building will be 80 × 45 ft., with a provision for any desired extension in the future. In the dynamo-room will be located two 100-HP. compound engines and two engines of the high-speed type, similar to the Porter-Allen, Straight Line, or Armington & Sims. The Corliss engines now in the department will be removed to this floor, leaving the Porter-Allen engine where it now is for the purpose of furnishing power to the mechanical workshops of the department, which will remain for the present in the basement of the Scientific building. These shops are to be considerably enlarged and improved, so that instruction may be furnished in carpentry, wood-turning, chipping, filing, blacksmithing, pattern-making and molding to fifty students at the same time, if this should be desired.

The electric lighting will be partly on the alternating and partly on the direct-current system. Two 500-light 1,000 volts alternating, and four 500-light direct-current dynamos are to be employed. As with the boilers and engines, it is proposed to use several types of American machines. The two alternating dynamos will be connected to a separate switchboard, and so arranged as to run either singly or in parallel, or one may be run as a motor. The direct-current machines will be compounded, but so arranged that by throwing a switch they become shunt machines. These will also be so connected to their switchboard as to run separately or in multiple. One alternating and one direct machine will be connected by belt to each of the compound engines; the remaining dynamos will be driven each by its separate engine. By this arrangement either dynamo or either engine may at any time of the day be used for experiment or instruction, as is the case with the boilers. This plant, in addition to the machines already belonging to the department, and including the motors for driving fans, will be larger and more comprehensive, it is claimed, than that of any institution in the country. Students will have actual practice in the handling of the entire apparatus, and will be enabled to obtain a very considerable familiarity with the details and peculiarities of the systems of the principal American manufacturers. The only shafting in the building will be on the second floor, and will be very light, as it is only for furnishing power for testing in the mechanical laboratory rooms, which are to be situated on this floor. Recitation-rooms, the department office and toilet-rooms will occupy the remainder of this floor.

On the third floor will be placed a drawing-room, recitation-room, office and the electrical engineering

laboratory, the latter occupying a space of 1,600 sq. ft. On one wall a special switchboard will be placed, so arranged that any or all of the dynamos can be connected at will with any measuring instrument or apparatus in the laboratory. It will be provided with a photometric room for measurements upon both arc and incandescent lamps, with many different types of which the department is supplied. The apparatus for electrical measurement is already quite extensive, and is continually and rapidly increasing. Each student is required to complete quite an extended course in elementary electrical and magnetic measurements; after which, if he is deemed competent, he will be given facilities for original research, either alone or in company with another student.

The feeder wires, both alternating and direct current, which convey the electrical energy from the dynamo-room to the various buildings, will be carried underground. The arrangement of the lamps in the buildings will be made by the architects, Wilson Bros., who have also drawn the plans for the entire plant. The plant, when completed, will be under the immediate charge of a superintendent, to whom the officers of the department act as advising and consulting engineers.

It is reasonably claimed, when the above plans are carried out, that the University of Pennsylvania will take a front rank among educational institutions for completeness of equipment and facilities for instruction in mechanical and electrical engineering.

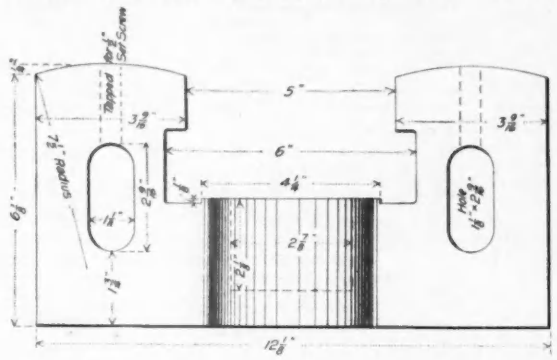


FIG. 4. ELEVATION OF FOUNDATION PIECE B B, SHOWING SLOTS FOR BOLTING TO RAIL.

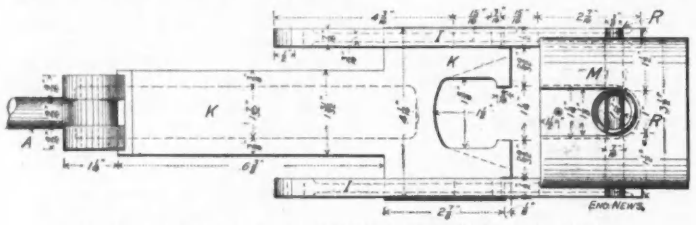


FIG. 3. PLAN OF MOVING PARTS OF TORPEDO MACHINE.

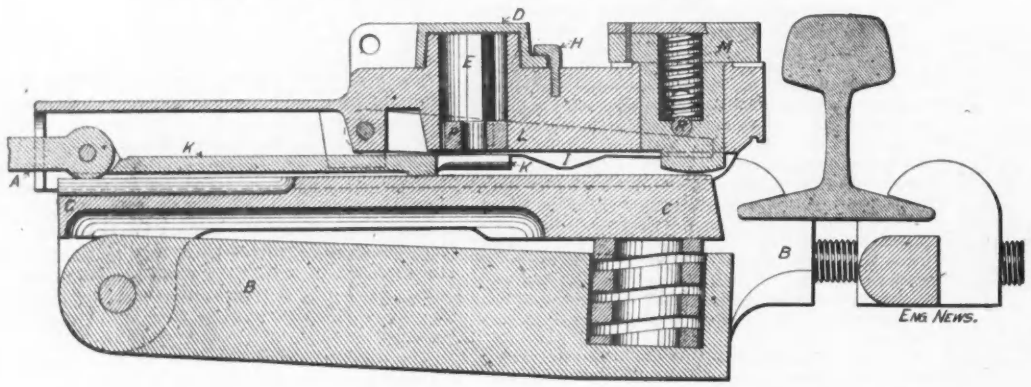
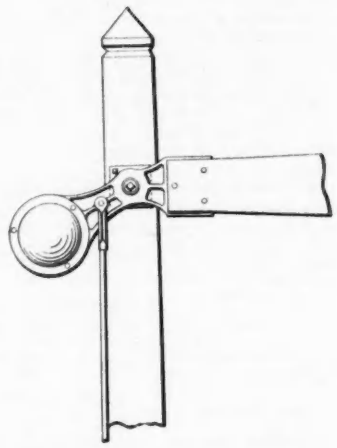


FIG. 2. VERTICAL SECTION OF NATIONAL SWITCH & SIGNAL COMPANY'S AUTOMATIC TORPEDO PLACING MACHINE.



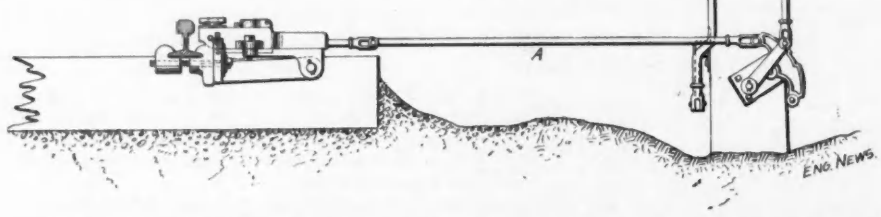


FIG. 1. AUTOMATIC TORPEDO-PLACING MACHINE CONNECTED WITH SEMAPHORE SIGNAL.

The National Switch & Signal Company's Torpedo-Placing Machine.

The collision in the Fourth Avenue tunnel in February last has aroused a great deal of interest in the subject of audible signals for giving additional warning to a locomotive engineer in connection with the visual signals of the block system.

The best known of the audible signals is the automatic torpedo-placing machine, made by the National Switch & Signal Co., of South Bethlehem, Pa. It has been on the market for some years, but owing to its limited use it is not very familiar, even to railway men.

This torpedo machine is a device intended to be placed beside a railway signal to give an audible warning by the explosion of a torpedo whenever a train passes the signal while set at danger. This it does by placing a torpedo under a hammer, set close to the rail where a passing wheel is sure to strike it, whenever the signal is put to danger, and withdrawing the torpedo again when the signal turns to safety. In case the torpedo is exploded by a train running past the danger signal, another torpedo automatically takes its place.

In the accompanying drawings, Fig. 1 shows the manner in which the machine is connected to an ordinary semaphore signal. The rod that works the semaphore has a slotted connection in which works a pin connected to a tilting lever, which by a vertical rod and a bell crank causes the horizontal rod *A* to be pushed in or out as the semaphore is moved to safety or danger. It will be noticed that the weight *W* on the tilting lever will cause the rod *A* to move to the left, setting the torpedo in position to explode, in case of any breakage of the rods which move the signal.

In Fig. 2 is shown a vertical section of the torpedo machine. The foundation piece *B B* is held in place by bolting to the base of the rail with two bolts an inch in diameter. To the rear end of this piece is pivoted a flat piece of iron, *C C*, whose upper surface forms a table on which the torpedoes are pushed forward for explosion. To this piece is bolted the upper part of the machine, which contains a reservoir for cartridges, a hammer for exploding them and suitable mechanism for bringing the cartridges into place.

The operation of this mechanism is as follows: Supposing the machine to be properly fastened to the rail and connected to the signal, the cover *D* to the cartridge reservoir *E* is lifted and a supply of cartridges is placed within; the weight *P* is placed on top of the cartridges to insure their moving down as fast as they are used. The cover *D* is fastened down by the hook-headed bolt *H*.

The rod *A* leads from the signal, as shown in Fig. 1, and is shown in Fig. 2 in the position corresponding to the safety position of the semaphore. When the semaphore is moved to the danger position, the rod *A* is moved to the right about 5 ins. To this rod is attached the torpedo pusher *K K*, shown in elevation in Fig. 2. Fig. 3 is a plan view of the torpedo pusher and the parts which move with it when the position of the signal is changed. The torpedo is held in the space *T*, Fig. 3, which is under the torpedo reservoir when the signal is in the position shown in Fig. 2. When the rod *A* is moved to the right, the levers *L L* are raised by the torpedo pusher *K K*, whose sides strike the inclined plane *I*, on these levers as it is pushed forward. Across the end of the levers *L L* is a horizontal rod *R*, passing through a slot in the hammer *M*. Thus the raising of the levers *L L* raises the hammer *M*, and the torpedo held in the space *T* is pushed forward to a position beneath the face of the hammer. Any wheel passing over the track when the machine is in this position will strike the hammer and explode the torpedo.

Of course this only happens in the rare instances where an engineer neglects to obey the danger signal. Ordinarily the signal is returned to safety, the torpedo is drawn back, and the hammer falls to the position shown in Fig. 2. If the torpedo explodes, however, its fragments are blown out of the open front of the torpedo holder *T*; and when the signal is returned to safety another torpedo drops from the reservoir *E* into the holder.

The details of this machine have been very carefully worked out, as may be seen by the drawings; and it has been made compact, simple and not liable to injury or derangement. An objection sometimes made to this machine is that it is liable to breakage by badly guttered wheels running over it. This, however, is not true if the machine is properly set. Fig. 2 shows the M. C. B. standard tread and flange for chilled car wheels. It will be seen that the heavy spring in the foundation piece on which the upper part of the machine rests permits a deflection of ¾-in. The top of the hammer is also $\frac{3}{16}$-in. below the rail level, so when the machine is in the position shown in the drawing a wheel guttered $\frac{3}{16}$ in. deep can pass over the machine without breaking it. But if many badly guttered wheels are to pass over the machine, it can be adjusted to a lower position. The foundation piece *B B*, shown in elevation in Fig. 4, has slots $2\frac{3}{16}$ ins. high, through which pass the bolts which hold the machine to the rail. By adjusting the bolts in these slots the machine may be lowered as desired.

The excellence of the torpedo as an audible signal has been thoroughly proved by many years of use in railway service, and the machine illustrated has proved a reliable means of utilizing the torpedo to enforce the warning given by the ordinary semaphore—much more reliable, it may safely be said, than the employment of human agency to effect the same end. Had this machine been in use in the Fourth Ave. tunnel, there is every probability that the fatal collision of Feb. 20 would not have occurred; and as the machines are not expensive, there appears no valid reason why they or some equivalent device should not be used at many such points.

The Comparative Merits of Various Systems of Car Lighting.

VI.

(*Continued from p. 465.*)

CHARGING THE CARBURETERS.

The arrangements for charging the carbureters are fully shown in Figs. 28, 29, 30, 31, already given, and in the following Figs., 40, 41. Fig. 40 shows the

Fig. 41. Gasoline Charging-Can House.

charging can, which is of 482 cu. ins. or 2.09 galls. capacity.

In charging it is stipulated first that there shall be at least 20 lbs. pressure in the air tank, and that the closet valve (just below the regulator, see Fig. 21, p. 428) shall be opened. The reason for this is that charging the carbureters is not allowed (at least by the more cautious roads) while the car is in service, and a certain amount of air pressure in the carbureters is necessary for the charging process. The regulator prevents more than 3¼ lbs. entering them, and the stipulation as to 20 lbs. pressure is merely to have enough margin to insure 3 lbs. speedily reaching the carbureters.

The charging can, Fig. 40, is then turned upside down and its nozzle placed in the filling valve (Fig. 30, and 18, Figs. 28, 29) where a slight turn of the can secures it in position, with a tight joint. A rubber tube is then attached to the side nozzle of the can and to the "discharge valve" of the carbureter (Fig. 31, and 16, Fig. 29). All four cocks (two on the can, two on the carbureter) are then opened, and the gasoline flows through the discharge valve into the carbureter and spreads all over the *top* of the inner mass of wicking, the gasoline being permitted to flow out by the entrance of compressed air above it through the discharge valve and tube, this discharge valve connecting with a pipe leading to the inner part of the bottom of the curbureter, in a manner easily imagined, but not clearly shown in the drawings we engrave, to fulfill the following functions:

As soon as the wicking has absorbed all it can, it will be clear that free gasoline will begin to gather in the bottom of the carbureter, which runs toward this discharge pipe. To determine when this has taken place, the workman slips off the rubber tube from the discharge valve from time to time. Air will at first blow out, but finally, when the interior wicking is completely saturated, liquid gasoline, there being 3 pounds pressure in the interior. When this occurs all four of the cocks are at once closed, the two cocks on the can and the cocks on the carbureter; afterward the charging can is disconnected from the carbureter and the lid to the cockbox closed.

"In a short time," say the instructions, "all the oil will be absorbed, and cannot be blown out except as a vapor or spray. Exhausted carbureters should take the full amount of oil for which they are rated without showing signs of overrating." It is obvious, however, that carbureters will usually be charged before they are fully exhausted, and hence that a small amount of unabsorbed gasoline is likely to be left in the bottom of the carbureter, which will be "overcharged." If so, this will be the first gasoline to be evaporated, and it will naturally soon be used up, leaving the interior "dry" as respects visible unabsorbed liquid. But to avoid leaving any liquid gasoline behind, as also to prevent any liquid gasoline escaping through the discharge valve of the carbureter, the former regulations, as established on the Pennsylvania R. R. and still in force on that road, require that the charging can be kept in place until all gasoline has been discharged into the carbureter that will enter it, and without removal of the rubber tube to test the interior status of the carbureter, and that the surplus unabsorbed gasoline should then be returned to the charging can as follows:

Close, first, the can filling-cock, then, an instant after, the carbureter charging cock; then disconnect at the charging cock, leaving the rubber tube still on, and set the can down upright. Then open the filling cock of the can, which permits the interior air pressure to escape from it, and the interior pressure in the carbureter will then force back any free or liquid gasoline which may be in the carbureter into the can.

This process takes a little more time, but it avoids (1) the slight escape of oil or gas in testing at the discharge valve; (2) the possible small quantity of oil left between the two filling valves in shutting them off (there being no instructions to leave an interval of time between these operations), and (3) a second loss through the discharge valve in testing if a carbureter be overcharged, which latter will be only occasionally done. It was formerly required by the company's instructions, but is not now, that the charging shall only be done in the daytime, when lamps are not burning, and when the car is not in service or in a station. The regulation of these matters is now left for each road to fix for itself.

The Pennsylvania road has its gasoline-charging cans filled at the refinery and shipped to them. The Norfolk & Western buys 5 bbls. at a time and stores it in a large tank. From 15 to 20 % evaporates in a few weeks if kept in barrels, however tight, the gasoline being so volatile as to escape through the pores and cracks of the wood. The company's instructions recognize this point, stating that "Gasoline should be stored in iron barrels of 100 or more gallons' capacity or in filling cans. It cannot be kept profitably in wooden barrels." The Pennsylvania and other roads use a "gasoline-charging canhouse" like Fig. 41 for storing the gasoline for the use of yardmen in charging. The building is of sheet metal, with a wood or iron frame, as shown, 9 × 12 ft., and is said tocost only $200, holding 80 to 111 cans, which is said to suffice in service for 100 cars.

The company's instructions were formerly contained in an explanatory pamphlet of some length, but the company advises us that this has now been entirely dispensed with, and the instructions to employees for managing the plant are now all contained in two folding cards for the pocket, one for yardmen, giving instructions for charging, and one for trainmen as to operating the lamps, it being very reasonably claimed that no one man is charged with both duties, and that the instructions were thus "boiled down considerably." In addition to the instruction as to routine details, which occupies only some 54 lines on both instruction cards together, the caution is added in large type to the filling instructions, "Use only 88° gasoline oil; test all oils for specific gravity before using," and, to the lighting instructions, "Keep the glass globes clean," and "Do not allow the lamps to smoke, and when passing through the car always look at them to see if they are burning properly."

The gasoline storehouse is placed at any convenient location in the yard convenient to the tracks. That at Altoona is about half a mile below the passenger station, near the old car shops. It is much

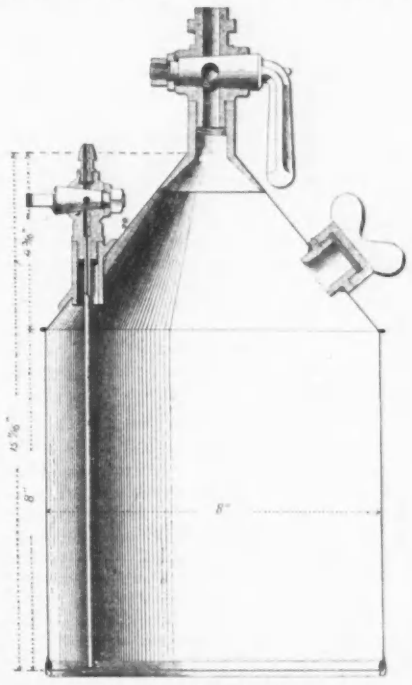


Fig. 40. Charging Can.

like Fig. 41, but stands upon posts. A board floor is used, sheathed with sheet metal.

The interior capacity of the copper carbureter shell is 2,112 cu. ins., or 9.14 galls. The total quantity of gasoline in a fully changed carbureter is somewhat under 4 galls.; of which some 2 galls. only can be evaporated before the gas becomes too poor and recharging becomes necessary. In this latter condition, though there is really a great deal of gasoline in the wicking, it is all but imperceptible to any other sense than that of smell, and not very noticeable in that way. We learn of no evidence

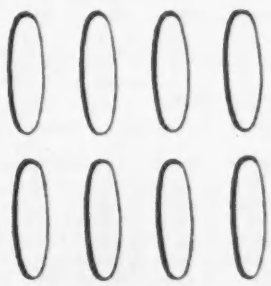


Fig. 42. Standard Perforations for Wicking, New Square Carbureter (full size.)

that the pores of the wicking fill up with extraneous matter and so degenerate materially, even after several years' service. Our impression is that carbureters will average in this respect at least 15 years' life, possibly more. We have seen samples of wicking from carbureters said to have seen several years' service, which were to all appearance good for many years' more service. Should the carbureter be charged by error with too heavy oil, it can be gradually expelled by lighter oil through the discharge valve, by running a few gallons of light oil through the carbureter.

It has recently been determined that it is desirable to enlarge the carbureter, and the carbureter now manufactured is 25 ins. square instead of round, in

creasing its interior capacity to about 2,413 cu. ins., or 28.6%. The square carbureter is the only one now manufactured or used by any one, we believe, except, of course, in stock already equipped. The effect of this is to increase the total absorbing capacity to nearly 5 galls., and the amount which can be burned out before recharging to 2.5 galls., or some 30%, thus affording that much longer service between chargings. Some additional absorbing capacity has also been obtained by increasing the amount of wicking used per square inch some 25%, thus making the mass of wicking solider. About 18¾ to 19 lbs. of wicking is now used in the square carbureter, against 12 lbs. formerly used in the round, an increase of 56 to 59 %, and the absorbing capacity should be increased in about the same proportion. It is proposed also to deepen the carbureter so as to obtain about double the former capacity.* More is claimed by the company in respect to time of service between rechargings than appears to be warranted by experiment. About 40 to 45 hours between chargings is the utmost that seems possible with the new lamps, and the new carbureter increases this to 56 to 63 hours, or, if deepened to double capacity, will give 80 to 90 hours.

The total length of the spiral passage in the wicking in the old circular carbureter is no less than 42½ ft., and in the new square carbureter about 60 ft. It goes without saying that there must be considerable resistance to the passage of air through such a long distance, and that the addition of more wicking will still further increase this resistance, but the additional capacity is considered to more than balance any disadvantage in this respect.

MISCELLANEOUS NOTES.

We find there is considerable difference in the commercial gasolines, which are all supposed to be of about 88° B. In Baltimore, and, we judge, in other cities also, the Standard Oil Co. always supplies gasoline which is really of 91° B. gravity for 88°, and this 91° gasoline boils at 82° Fahr. under 3 lbs. pressure, which is almost exactly the point which it should boil at according to the diagram given in Fig. 1 (issue of April 18, 1891), at atmospheric pressure. We are not as yet accurately informed as to the effect of 3 lbs. or 5 lbs. pressure on the boiling points of gasoline of various proofs, but shall be able to give it before conclusion of these articles.

The bursting pressure of the carbureter is about 60 lbs. per sq. in.; 30 lbs. will never break it, and the proof test is 20 lbs. The precautions against overpressure are (1) the regulator, (2) the safety valve, (3) with the Bowman regulator, that all air supply passes through a $\frac{1}{8}$ to $\frac{1}{32}$ in. hole (0.062 to 0.031 in.), the exact sizes used being 0.04 in. for 3 lamps (of the old style, burning about one-third as much gas per hour as the present style), 0.052 for 5 lamps, 0.072 for 10 lamps. It is to be noted that this passageway is not greatly larger than the by-pass aperture ($\frac{1}{32}$ in.), but there is considerably more difference in pressure in most cases beyond doubt. Still, the Bowman regulator has been found unreliable, and is not now used, and, in our judgment, in part because the by-pass regulates the air supply after the lamp and carbureter are once well warmed up, nearly or quite all the air which is used passing through the by-pass.

The reasons for this conclusion will appear more fully later.*

Summing up the old round carbureter weights:

The wicking weighs	12 lbs.
The copper case complete weighs	18½ "
The interior meter parts weigh	21 "
The outer mantle, etc., complete, weighs	83¼ "
Total weight of empty carbureter and case	135 lbs.
The charge of galls. gasoline weighs	21¾ "

The P. R. R. standard tank, 10 ft. 3 in. long and 16 ins. diameter, is tested to 300 lbs. and charged ordinarily with air at 70 lbs. It has been found to run a car with freshly-charged carbureters about 8 hours, and with nearly empty carbureters 3½ to 5 hours. To see how this compares with the capacity of the brake pipes to supply air, a Westinghouse 8-in. pipe, under ordinary working conditions, will about keep air flowing through a ¼-in. hole at 60 lbs. pressure.

The interior capacity of this tank is about 14 cu. ft., which, if charged with air to 65-68 lbs. pressure, will hold about 4⅝ times its volume of air at 18 lbs. pressure, or some 65 cu. ft. of air, or 13 cu. ft. per lamp with 5 lamps per car. According to these figures, therefore, each lamp when the carbureters are full should use about 1⅝ cu. ft. of air per hour, and when the carbureters are nearly empty 3.7 to 2.6 cu. ft. per hour. In Mr. PENNIMAN'S tests as recorded in Table III. (p. 392 of ENGINEERING NEWS of April 25), he consumed almost exactly the same amounts per lamp. Other records of the Pennsylvania R. R., however, indicated 2½ and 5 cu. ft. per lamp per hour of air consumption, but this, we infer, was for tests when the lamps had not been burning very long, and hence when the air consumption was larger than after long burning.

It is estimated on the Pennsylvania R. R. that, on an average of the whole year, cars in service are lighted for 3 hours per day, 4½ in winter, and 1½ in summer. Cars on long runs, however, are lighted all night, so that there is much inequality between different cars. A car with 6 lamps of the new style of burner will burn about a quart an hour of gasoline, which is at the rate of 3.63 oz. avoir. per lamp per hour, Mr. PENNIMAN having found about 4 oz.*

In the new square carbureter, in which the holes for the wicking are punched a little closer than was formerly the custom, there is one oblong hole of 0.125 sq. ins. area for each 0.370 sq. ins. of area, as shown full scale in Fig. 42. This shows that a little over one-third of the total area of the "heads" (through which the wicking is drawn) is occupied by the wicking where it passes through them. As the wicking is here very much compressed, the interior space between them is doubtless very completely filled by the wicking when fully saturated with gasoline, the fluid gasoline itself being of such bulk as to occupy about 45% of the interior space of the carbureter.

In regard to some of the preceding statements as to the capacity of the carbureter and its hours of endurance, Dr. CHAS. B. DUDLEY, Chemist of the Pennsylvania Railroad, writes us as follows:

It is a mistake to say that only 2 galls. of the gasoline in the carbureter can be burned out. In order to make this clear, we will say that we have several times on a car during test filled a carbureter full, namely, a little less than 4 galls., and burned it down, so that it would take from 3 to 3¼ galls. to recharge it to the same condition that it was when the test began. Apparently reliance was placed on Mr. PENNIMAN'S test of 40 hours, burning 6 ozs. of gasoline per hour. There are some unexplained difficulties connected with that test, however, which we have not been willing to regard as satisfactory, and we are inclined to think that in this view the carbureter people coincide; not that Mr. PENNIMAN did not do fairly, but that the carbureter was not properly set up. The reason why the charging can holds only 2 galls. is because we want a certain margin. If the carbureter will hold from 3½ to 4 galls., and will burn down satisfactorily to a point where it leaves one gallon in the carbureter, we can then add 2 galls. of gasoline without any danger of overcharging the carbureter; in other words, with a 2-gall. charging can and ordinary conditions of service, there would always be a half-gallon of capacity under extreme conditions left as a margin against overcharging, and this we deem good practice, so that it is not correct to say that only 2 galls. can be burned out.

As to the arrangement of the smoke bell and endurance of lamp, we will say that we have recently had the plate in the smoke bell taken out of the lamps on car 418, and that the car has burned since that time from 80 to 90 hours with the inverted lamps, and without any difficulty. There is really no necessity for the plate in the smoke bell, as the carbureter people claim. The car has been in constant service, and the light is perfectly satisfactory, except that as the carbureter gets nearer exhaustion the amount of light is diminished. It will be necessary, therefore, if it is desired to express the actual state of the case, to modify the figures given as to the amount of time between chargings. Of course if the capacity of the car is to determine the amount of time between chargings, 40 to 50 hours is perhaps all we will get. On the other hand with larger carbureters, or with a change in the charging can, which has been under discussion for some time, considerably more time can be obtained.*

Dr. DUDLEY also says in another note:

"We find to our regret that the inverted lamps which we have in service, have the smoke bell as shown, but we regard this as a very serious mistake, and as soon as we can make the change, we hope this practice will be abandoned. We do not approve of it, and we are inclined to think that the carbureter people themselves are weakening in regard to their advocacy of it."

DR. DUDLEY will hardly need any assurance from us, we trust, that it is desired "to express the actual state of the case," but he will pardon us for suggesting that the above corrections are a little confusing. In the first paragraph it is stated that it is deemed good practice to have only a 2-gall. charging can, in order to leave a certain margin against over-filling. In the next it is claimed that we should modify our statement, that 40 to 45 hours is the limit of service for the new lamps, because, with "larger carbureters or a change in the charging can, which has been under discussion for some time, considerably more time can be had," though if the capacity of the can is to determine the time between chargings "40 to 50 hours is perhaps all we will get," or substantially what we said.

As to how much gasoline can be burned out of a full carbureter before exhaustion, we are quite ready to believe that at times much more than 2 galls. may be burned out if a power light will be accepted, and doubtless it depends a good deal upon how the lamp is being burned, whether to give much or little light, whether gas will cease to be supplied fast enough and rich enough to maintain the flame in *status quo*. Mr. PENNIMAN'S tests, as recorded in the beginning of these articles, were made to show the lamp at its best in regard to volume of light, being accompanied by photometric tests, and they showed that the lamp burned well for 42 hours, until a little less than 2 galls. had been burned, and then quite suddenly began to flicker and fail. This shows conclusively that *for giving the full light of the lamp*, as tested by Mr. PENNIMAN, somewhat less than 2 galls. was the burning capacity of the carbureter, and, as that chances to be also about the capacity of the standard charging can, the inference is natural that it is about the *certain* endurance of the carbureter, though at times it may burn out considerably more. Of course, with the new square carbureter the burning capacity and proper size of charging can will be increased pro rata with the interior capacity.

As to whether Mr. PENNIMAN'S experimental plant was or was not properly set up to fairly represent P. R. R. practice is now being made the subject of further test, and we therefore can express no opinion on it. The plant was set up by the Frost Company, and to their satisfaction, and certainly corresponded in all discoverable respects with *their plant, as they have been manufacturing it for a year or two past*, and furnishing it to railway com-

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* In regard to the recent and proposed changes of the carbureter the company writes us: "A number of changes that have been made in connection with our car-lighting system of considerable importance, principally the reconstruction of the carbureter from circular to square. The circular carbureter gave from 55 to 60 hours' service, and the new square one will give about 125 hours, the principle being the same. We are also changing the construction of our inverted lamp at the suggestion of the Pullman Palace Car Co., and we have found by experimenting that it will increase the candle-power illumination about 20%. Therefore, instead of getting an average candle power illumination of 90 with the present lamp, by a slight alteration in its construction we will be able to get in the neighborhood of 120 c. p.

"Our light stands upon its own merits, and will supersede others in a very short time, owing entirely to its superiority in every conceivable sense. The Pullman company has now adopted it as its standard, and is equipping its cars very rapidly; in fact, we cannot get the material out fast enough for them. When it is taken into consideration that in one item of expense alone, that with our system of car lighting, the Pullman company will save not less than $200,000 per year by saving their carpets from oil drippings, this to them is one of its greatest recommendations."

* The purpose of the by-pass is thus explained by the company:

When the carbureters are freshly charged, or when the air is very warm, there is a possibility of carrying too rich a gas down to the lamps. To obviate this difficulty a permanent cross connection is made between the air inlet to and outlet from the carbureter. In this cross connection is a diaphragm with a very small hole, so that a small amount of air is taken across to the gas as it comes out of the carbureter, diluting it a little, and thus preventing any possibility of too rich or too smoky a gas reaching the lamp.

* The distinction between *fluid* ounces and *avoirdupois* ounces is to be kept in mind. There are 128 fluid oz. and only 87 avoir. oz. in a gallon of 88° B gasoline.

* The cone put into the smoke bell was not put in to slightly check the free escape of heated air and gas as stated in the article, but for the purpose of preventing the in-rush of air (which occurs when the brakes are suddenly applied) from putting out the light. It was found that the cone deflected the air currents away from the top of the lamp, and thus they did not result in pushing down the products of combustion on the flame and extinguishing it. Our first construction had no cone, and we would prefer this now, but the cone or some other device seems essential to prevent extinguishing the light, when the brakes are suddenly applied.

panies generally, and for a considerable number of cars on the Pennsylvania road. As certainly, the experimental plant did not correspond in some minor details which may have important effect with P. R. R. practice as developed on that road, and as exclusively practiced two years ago, and for the most part since.

The disputed points of difference lie wholly in the arrangements for passage of the gases of combustion upward, which in the P. R. R. plant is quite free, but in the present plant, as constructed by the Railroad Lighting and Manufacturing Co., considerably obstructed, with the double end of keeping downward drafts from affecting the lamp and of throwing more heat around the carbureter, so as to cause a freer vaporization of the gasoline, as to which we shall give more details in the next following article.

That article will close our description of the Frost dry carbureter plant, and will be devoted to a review of its functional action. It will contain many facts not as yet generally known, and will be the most important as yet published for those interested in the question of car lighting.

Notes on English Railways.

(*Continued from page 478.*)

NORTHEASTERN RAILWAY.

The main line of this system forms the middle link of the East Coast route between London and Scotland, connecting the Great Northern Ry. at York with the North British Ry. at Berwick, on the Scottish border, a distance of 147 miles. The Northeastern Ry. engines haul the express trains over the latter road as far as Edinburgh, 204½ miles from York. On this main line there is some very fast and heavy passenger traffic, especially during the season when the "race to the north" is in progress as a competition between the East Coast, West Coast and Midland routes (ENGINEERING NEWS, Feb. 7, April 11 and May 9). Apart from this, the road is not noted for fast service, owing partly to absence of competition on its other lines and partly to its very heavy freight traffic. There are numerous large manufacturing towns on the system, and the freight traffic from these makes it difficult to work fast passenger traffic. The total length of the system is 1,578 miles, and among the principal towns upon it are Newcastle, Gateshead, Hull, Leeds, Stockton, Darlington, Hartlepool, Sunderland, Shields and Berwick.

Track.—The most interesting feature about the track of this road is the use, on some sections, of heavy steel flange rails on steel cross-ties. The ties are of trough section, with open ends, of a type designed by Mr. J. CABRY, Chief Engineer of the road. They are 8 ft. long, 8 ins. wide on top, 12 ins. wide at the bottom, 3½ ins. deep, and have a uniform thickness of ⅜ in. They weigh 150 lbs. each. They are stamped to shape, and in the operation lugs or jaws are pressed up out of the metal. There are 11 ties to a rail length of 30 ft. The rails weigh 91 lbs. per yd. They are 5⅛ ins. high and 5½ ins. wide over the base. Each rail is secured to the tie by a lug on one side and a taper key driven between the flange of the rail and a lug on the other side. Full details of this track are given in the writer's report to the U. S. Department of Agriculture on the use of metal ties for railways. The standard track is of the ordinary English type, with 90-lb. bull-head rails in chairs, each of which is attached to the tie by 4 fastenings. The rails are laid with square suspended joints, spliced by plain splice bars weighing 26 lbs. per pair, with 4 button head bolts having their heads on the inner side of the rail. The wooden keys are on the outer side. Ash ballast is used, and is level with the tops of the ties. The steel ties and flange rails make a very good track, and the cost per mile of single track is $7,046, as against $6,334 for the ordinary rails and chairs on wooden ties. The only other case in England where flange rails are used on trunk lines is on the Furness Ry., which has some track of the Sandberg type, consisting of 100-lb., flange rails resting on steel tie plates. Near Morpeth is a high masonry viaduct, with low parapets and no guard rails. The station at Newcastle is a terminal. Through trains run in, the engine is uncoupled, and another engine is attached to what was the rear of the train.

Locomotives.—The special feature of the locomotive equipment of this road is the extensive use of the two-cylinder compound system for passenger, freight and tank engines. They were introduced by Mr. T. W. WORSDELL, Locomotive Superintendent, who also introduced this system on the Great Eastern Ry., when Locomotive Superintendent of that road, as described in ENGINEERING NEWS, March 14. They are of the type known in England as the Worsdell-Von Borries type, which is a modification of the original Mallet type. The most celebrated of the Northeastern Ry. compounds are the very large express engines of the type shown in Fig. 61 having inside cylinders, a four-wheel leading truck a single pair of driving-wheels 7 ft. 7¼ ins. diameter and a single pair of trailing wheels. One of these engines is said to have attained a speed of 86 miles per hour. All the engines of this road have inside cylinders, and those with large cylinders have the slide valves on top of them. Formerly the engines with four coupled driving-wheels had a single pair of leading wheels, but the four-wheel truck is now being extensively used, making the engines of the American eight-wheel type. The truck wheels are 43½ ins. diameter. The cabs have a rather American appearance. The boiler, cab, wheels, splashers, tank, etc., are painted a bright yellowish green, with black and white striping. The frames are a dark chocolate or plum color. The dome is of brass, and the smoke-box and small smoke-stack are black. The Westinghouse automatic brake is used, with brake shoes on the driving wheels. A few engines and cars for interchange traffic are fitted with the vacuum automatic brake as used on the Midland Ry. The company's main works are at Gateshead-on-Tyne, but it has also works at Darlington, where mainly freight engines are built and repairs made. The old "Puffing Billy" locomotive of the Stockton & Darlington Ry. is to be seen on a pedestal near the High Level bridge over the Tyne at Newcastle. The following are the dimensions of the four leading types of compound engines. The tank engines are for mineral service, and their average load is 40 coal cars carrying 10 tons each, and weighing 16 tons including car and load, or a total train load of 640 gross tons.

	Fig. 61. Single Driver.	Fig 62. Four-coupled.	Fig. 63. Freight.	Fig. 64. Tank.
Cylinders.				
h. p.	20 × 24 ins.	18 × 24 ins.	18 × 24 ins.	18 × 24 ins.
" l. p.	28 × 24 "	26 × 26 ins.	26 × 24 ins.	26 × 24 ins.
Diam. truck wheels	3 ft. 7¼ins.	.....	.....	.....
Diam. leading wheels	.....	4 ft. 7¼ins.	5 ft. 1¼ins.	.....
Diam. driving wheels	7 ft. 7¼ins.	6 ft. 8¼ins.	5 ft. 1¼ins.	5 ft. 1¼ins.
Diam. trailing wheels	4 ft. 7¼ins.	6 ft. 8¼ins.	5 ft. 1¼ins.	3 ft. 9¼ins.
Diam. boiler outside	4 ft. 3 ins.	4 ft. 6 ins.	4 ft. 3 ins.	4 ft. 3 ins.
Boiler pressure, lbs.	175	170	160	160
Tubes, No.	203	242	203	203
" diam., outside	1¾ ins.	1¾ ins.	1¾ ins.	1¾ ins.
Tubes, l'ngth	10ft. 11⅛in.	10ft. 11⅛in.	10ft. 11⅛in.	10ft. 11⅛in.
Ht. surface, tubes, sq. ft.	1,015	1,211.3	1,026.12	1,026.12
Ht. surface, firebox, sq. ft	123	112.0	110.00	110.00
Ht. surface, total, sq. ft.	1,139	1,323.3	1,136.12	1,136.12
Grate area, sq. ft.	20.7	17.33	17.23	17.23
Driv. wheel base	.....	8 ft. 8 ins.	16 ft. 6 ins.	16 ft. 6 ins.
Total wheel base	21ft. 11 ins.	16 ft. 5 ins.	16 ft. 6 ins.	22 ft. 6 ins.
Weight, lbs.: Truck	35,672	.....	.....	†19,544
Lead whls	.....	28,856	31,752	†33,544
Driv. whls.	39,760	40,208	34,720	†33,264
Trail. whls.	29,120	27,972	27,216	†34,832
Total	104,552	97,076	93,688	121,184
Tank, U. S. galls.	4,728	3,180	3,180	1,560
Coal space, lbs	8,960	8,960	8,960	4,480

* Small trailing wheels. † Coupled wheels.

Rolling Stock.—The majority of the passenger cars are of the ordinary type carried on 2 or 3 rigid axles. The cars are painted a dark crimson not unlike those of the Midland Ry., but darker and of a more purple shade. The equipment includes some snow plows. The company's car works are at York.

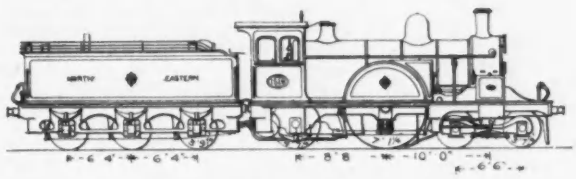

Fig. 61. Single-Driver Passenger Engine.

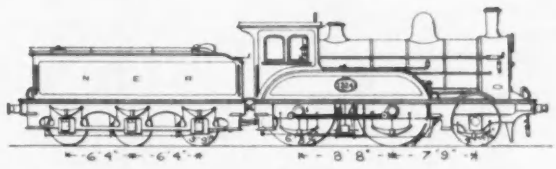

Fig. 62. Four-Coupled Passenger Engine.

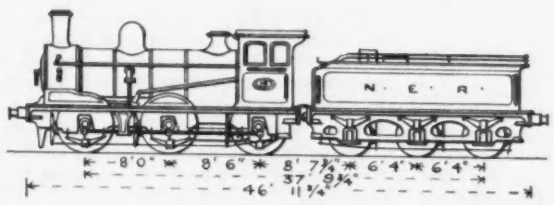

Fig. 63. Freight Engine.

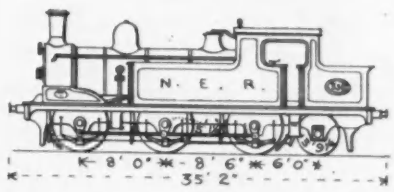

Fig. 64. Tank Engine.

COMPOUND LOCOMOTIVES, NORTHEASTERN RAILWAY, ENGLAND.

SOUTHEASTERN RAILWAY.

This system has an aggregate length of 426 miles, and, like the London, Brighton & South Coast Ry. (ENGINEERING NEWS, March 21), it does not serve a manufacturing district, but depends mainly upon passenger traffic for revenue. The line is in several ways far behind the times, the result, apparently, of a too conservative policy. It has long been a by-word in England for slow and unpunctual trains miserable rolling stock and high fares, and, though within the last few years many improvements have been made, especially in the locomotive equipment, the road, as a whole, is by no means a good example of modern English railway practice. A general air of slovenliness and carelessness is very noticeable, especially among the trainmen and employees at the stations. Many express trains carry only first and second class passengers. There are two large terminal stations in London, at Charing Cross and at Cannon St., both on the north bank of the Thames, approached by wide bridges, and connected by a loop line on the south bank, over which there is a continuous and complicated traffic. A train arriving in London runs into the Cannon St. station,

and an engine is then coupled onto the rear to take the train to Charing Cross. Trains from London leave Charing Cross and run to Cannon St. in the same way. On this loop line the trains keep to the right, in order to facilitate the handling of the traffic at the crossings of the numerous interlacing tracks. In the summer there is a heavy tourist and excursion traffic to the several popular seaside resorts served by this system. The company also runs a special service of express trains in connection with its channel steamers between Dover and Calais, and between Folkestone and Boulogne. Among the principal coast towns on the line, and their distances from London, are the following: Dover, 75½ miles; Folkestone, 69¾ miles; Hastings, 60 miles, and Ramsgate, 84½ miles.

The president of this company is also president of the Manchester, Sheffield & Lincolnshire Ry., which

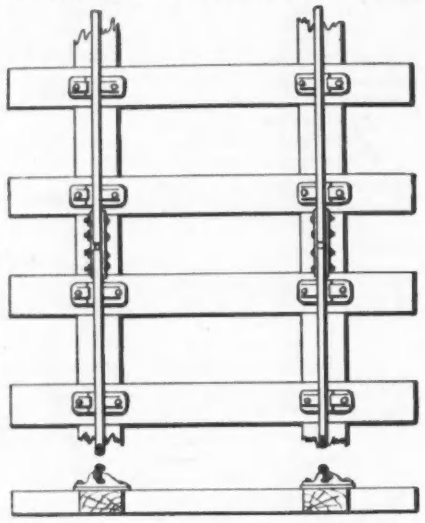

Fig. 65. Arrangement of Ties Across Bridge Floors; Southeastern Railway, England.

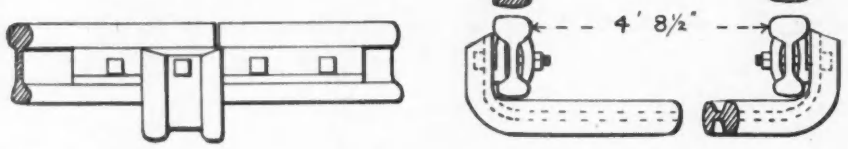

FIG. 66. OLD RAILS USED FOR TIE-BARS AT SWITCHES; SOUTHEASTERN RAILWAY, ENGLAND.

is trying to obtain an independent line from the north into London, as noted on page 390. If this project is successful it is quite probable that the new railway and the Southeastern Ry. will be eventually connected by a line across one of the busiest parts of London, which line would not only accommodate through traffic between the northern and southern railways, but would also have an enormous local traffic.

Track.—The track is of the standard English type, but is lighter than that of the northern main lines. The chairs are small, and are secured to the ties by only two fastenings to each chair. The wooden keys are on the outer side of the rails. The rails are laid with square suspended joints spliced with plain splice bars and four bolts with square heads and nuts, the latter being on the inner side of the rail. The outer bar has a rib near the bottom to prevent the bolt heads from turning. In Charing Cross station some inside splice bars of the Samson type, of varying thickness, were noticed. The ballast is of gravel and covers the ties. On some bridges the chairs are carried on longitudinal timbers, on others they are on cross ties, with spacing blocks between the ties as shown in Fig. 65. The detector bars of the interlocking apparatus are attached to arms on a rod parallel with the rail. This rod turns on its axis, moving the bar in a curved path tangential to the rail. The form of detector bar generally used on other lines is an angle or tee iron moving parallel to the rail. An interesting feature is the use of old rails to maintain the gage at switches. The arrangement is shown in Fig. 66, and is applied at the rail joint nearest to the point of the switch. It was noticed at Charing Cross, and is probably used as a precautionary measure at other places on the busy London lines.

Locomotives.—The road has some very fine engines of recent construction, which were designed by Mr. JAMES STIRLING, Locomotive Superintendent, and built at the company's works at Ashford. One of these engines, of the eight-wheel type, was described and illustrated in ENGINEERING NEWS, Feb. 22, 1890, but the brake used is the automatic vacuum, and not the Westinghouse, as stated in that article. For local and suburban traffic there is a large number of compactly built, powerful, side-tank engines, with four-coupled driving wheels and four-wheel trailing truck, being very similar to the engine illustrated in Fig. 27, p. 304. The laminated springs of the trucks of the eight-wheel engines are very short, and are connected by equalizing levers. Some of the old engines had no cab, but only a vertical weather board across the end of the boiler, and bent round to form a slight protection at the sides. Two glass disks were fitted in the weather board. The engines were formerly painted a light green, with Indian red frames, black and white striping, and brass domes and safety valve casings, etc. The newer engines are now painted black, with red and yellow striping. The vacuum automatic brake is applied to the driving wheels.

Rolling Stock.—For the main-line trains there are now many long cars on four-wheel and six-wheel trucks. The former have 6 or 8 compartments, the latter being third-class cars having 8 compartments, and accommodating 80 passengers. The former have generally 7 compartments. The first-class compartments of these cars are 7 ft. 6 ins. wide, 7 ft. high and 6 ft. 6 ins. between partitions, seating 6 passengers. The majority of the main-line equipment, however, consists of cars on 2 or 3 rigid axles, the latter being the standard. These cars as now built are all 8 ft. 0¾ ins. wide, 7 ft. 6 ins. high at the middle, and are 30, 33 and 34 ft. long for first, second and third class respectively. The latter are divided into 6 compartments, accommodating 60 passengers. The cars are built at the company's works at Ashford. Mr. WM. WAINWRIGHT is Superintendent of the car department. Some of the modern cars have turtle back roofs and lavatory accommodations. Nearly all the cars have Mansell wheels, with solid wood filling. Oil boxes are generally used. The cars used to have a very gay appearance, being painted a purplish brown or plum color up to the window sills, and a bright pink above, with gilt lettering and striping. They are now painted a dark plum color all over, with a very little gold striping. The old style is still maintained on a few saloon cars, which are short four-wheel cars, upholstered in red, and having bright red window curtains. Some parlor cars for the company's "continental" express service in connection with its Channel steamers are now being built in the United States.

For local and suburban service very short four-wheel cars are used, closely and permanently coupled together in trains of 12 or more cars, and looking like one long articulated car. Some of these have only about 9 ins. between the car bodies. A link-and-pin coupling similar to those shown in Figs. 34 and 58, pp. 341 and 477, is used, with spring buffers on each side, placed close to the couplings instead of at the corners of the cars. The brake hose is led along under the cars, the space between them not being wide enough for the usual arrangement of vertical pipes at the ends of the cars (Fig. 60, p. 478). These cars have generally 5 third or 4 first-class compartments (50 or 24 passengers). On some of these trains very antiquated, small, dirty, bare and uncomfortable cars are used, which are popularly termed "rabbit hutches," and which are more suitable for a museum than for railway service. The side sheathing is of horizontal planks nailed to the inner side of the posts and frames. The third-class cars of this kind have 3 compartments with windows only 12 × 15 ins., and one dim lamp to two compartments, while they are absolutely bare and devoid of upholstering.

The Smith non-automatic vacuum and the automatic vacuum brakes are used, being applied to most of the engines, tenders and cars for passenger trains, but neither of them can be applied by the conductors, or "guards." Some cars are fitted with two sets of brake-pipe and hose, one being a single hose, and the other two hose at the ends of a horizontal T branch at the top of the vertical iron brake-pipe. Some "horse-boxes," or cars for carrying horses, also have the double set of pipe and hose. These are short four-wheel cars, about as high as they are long, and looking very top-heavy. In each compartment of the passenger cars is a map of the company's system. The trains are fitted with electrical intercommunication, the connections between the cars being made by loose hanging sections of rusty wire. In each compartment is a knob or bell-pull, near which is posted the following notice:

COMMUNICATION WITH GUARDS.

When the bell-pull is drawn slightly forwards, as far forward as it will come, bells in the guards' van will ring, and will continue ringing until the train is stopped; at he same time a signal will appear outside this compartartment. Passengers cannot replace the bell-pull.

Caution. Any passenger who makes use of the said means of communication without reasonable and sufficient cause shall be liable for each offense to a penalty not exceeding five pounds. 31 and 32 Victoria, Cap. 119, July 31, 1868. E. E. R. T.

(To be continued.)

PERSONALS.

Mr. WINFIELD S. GAMBLE has been appointed City Surveyor of Elgin, Ill.

Mr. W. T. MCLEAN, of Sidney, O., has been elected Secretary of the Ohio State Board of Public Works.

Mr. HENRY SHERMAN, for 8 years Superintendent of the Ninth Ave. Street Ry., died in this city May 9.

Gen. J. M. CORSE, of Boston, has been elected General Manager of the Flint & Pere Marquette R. R.

Mr. CHARLES G. ELLIS, President of the Schenectady Locomotive Works, of Schenectady, N. Y., died May 15.

Mr. JOHN G. SNELL, Master Car Builder of the South Atlantic & Ohio R. R., at Bristol, Tenn., has resigned.

Mr. JAMES B. HUNTER, one of the engineers on the Niagara Falls water-power tunnel work, died May 13, of typhoid fever.

Mr. EDMUND B. WESTON, of Providence, R. I., was elected member of the Institution of Civil Engineers of Great Britain, May 5.

Mr. CLARENCE COLEMAN, of Roanoke, Va., will carry on the business of the firm of Coleman & Salye, the firm having been dissolved.

Mr. JOHN MACLEOD has changed his office from the *Courier-Journal* Building to the Kentucky National Bank Building, Louisville, Ky.

Mr. EDWARD DICKINSON has been appointed Assistant General Manager of the Union Pacific Ry., to succeed W. H. HOLCOMB, resigned.

Mr. W. W. STEARNS has resigned his position as General Superintendent of the Eastern Division of the New York, Lake Erie & Western R. R.

Mr. CHAS. MACDONALD is to deliver an address before the students of the Rensselaer Polytechnic Institute at the commencement next month. Mr. MacDonald graduated from the Institute in 1857.

Mr. E. N. RIOTTO, Mining Engineer, and proprietor of the New York Metallurgical Works, of New York, N. Y., was killed May 7 at the Herring gold mine, in North Carolina, while making an inspection of the works. He was riding on a dump-car across a trestle, when the catch gave way and the load was dumped, throwing Mr. RIOTTO off the trestle.

NEW PUBLICATIONS.

—*The Railway Problem.* By A. B. STICKNEY, St Paul. D. D. MERRILL Co., 8vo ; pp. viii +249; numerous diagrams; cloth, $2; half leather, $2 50.

In this book we have the latest addition to the already large volume of literature dealing with the economic and financial questions arising from our railway transportation system. The position which the author holds as a practical railway manager and the reputation which he has gained from the views which he is known to hold in regard to the causes of the evils prevalent in the management of our railways, and the remedies for their prevention, would entitle the book to more than a superficial notice, even though the subject matter was less worthy of consideration than it is. For the past 20 years Mr. STICKNEY has been officially connected with the transportation departments of various Western railways; and he now holds the position of Chairman of the Board of Directors of the Chicago, St. Paul & Kansas City Ry. The field of his official duties has been the section of our country where during the last 20 years rate wars, discrimination, overconstruction and hostile legislation have assumed their most violent phases Being thus in the thick of the fight, he is particularly well qualified to describe from the standpoint of a combatant the battle and its causes and effects. This he does, fairly as he sees it, in the book before us. As is natural, the investigation is confined largely to the territory with which he is familiar through his life's work. His criticisms and conclusions, however, are as true for any other section of the country.

The first part of the work is taken up with an account of the growth of the Western railway system, and of the competition, abuses and legislation which resulted from it. The management of the railways is trenchantly criticised. Unjust discrimination is considered the cause of all legislation; the so-called "Granger Laws" and kindred legislation has been only to prevent discrimination and to protect property from destruction by the railways; the rates established by these laws have not been too low but were fair and proportionate; the railway managers are alone responsible for the present unsatisfactory condition of affairs. The author's opinions on these points are in a large measure summed up in the following excerpt from chapter ix.:

"The truth is—and it is time the investing public should be told the truth—it is not the so-called "Granger laws," nor the acts of commissions, which have reduced the rates of transportation to the present unprofitable level, but the mismanagement of the companies. For more than 20 years the managements of the Western railways have been engaged in the prosecution of rate wars, in which it was impossible to decide which was acting on the offensive and which on the defensive. Each manager has surrounded himself with a standing army of freight and passenger agents, contracting agents, soliciting agents, advertising agents, traveling agents, clerks, type writers and runners. In every important city, and in many of the unimportant towns, detachments of each of the companies have been permanently quartered, occupying the most expensive offices at the most conspicuous corners of the most important streets. Hardly a day has passed during 20 years without active engagements in each city, in which all the forces have been under fire. No expense has been spared to equip them with the latest and most expensive arms. The arts of the printer, the lithographer, and the engravers on wood and steel have been exhausted. Theatre tickets, credits at livery stables and "et ceteras" have been supplied without stint, and "no questions asked." The expenses of the standing armies have been enormous; but, like all standing armies, they are consumers and not producers. Their mission is to destroy, All of them together have not in twenty years produced a single ton of freight. Their whole duty is to get the freight which others have produced routed over their line, "honestly if they can, but get it.' After two nations have been at war until the resources of both are exhausted, and a treaty of peace has been concluded, the first step toward making it permanent is to disband their armies, or, at any rate, withdraw them to the interior. As long as they are on the frontier, face to face and under arms, no continuous peace is expected."

"From time to time during the 20 years' war the chiefs have made solemn compacts of peace. These treaties have been signed, sealed, and delivered with all the necessary solemnities, but not once have they withdrawn or disbanded their forces. For a few days at a time have they slept with their guns loaded, only to renew the contest on the first pretext with renewed vigor and destructiveness. This has been the true cause of the destruction of revenues, instead of 'Granger laws' or 'State Commissions.'"

The managers know it, but they have been too cowardly to avow it. "Hast thou eaten of the tree whereof I commanded thee that thou shouldest not eat?" was demanded many years ago. "And the man said, The woman, whom thou gavest to be with me, she gave me of the tree, and I did eat."

This sneaking, pusillanimous trait of the first man has descended through more than 200 generations of men to the railway management of the nineteenth century. And the managements said, "The laws and the commissions they gave me of the tree, and I did eat."

In regard to the present method of rate making the language is equally strong. The conditions attaching to it are wholly arbitrary, and rates are made not with regard to any mathematical proportion to each other or to anything else, but are merely the arbitrary decisions of the maker, and are devised only to secure traffic, under what conditions is immaterial.

That the greater part of the foregoing is true will be admitted. Whether the remedies proposed are feasible is another question. The author holds that it is not only the right but the duty of the state to protect the people against discrimination, and that this can best be done by fixing rates. Starting with this hypothesis he has devised a system of rate making which he considers feasible. The first step is to classify the commodities transported. The second step is to determine the relative rates upon the different classes; that is, what the ratio of the rates upon one class shall be to the rates of other classes. The third step is to determine the actual rates. The problem presented in the first two steps must be settled upon the two principles of "what the traffic will bear" and public policy, as seems best by the judgment of the sovereign state; the state's action to be limited only by the contract obligation to allow the companies to obtain, if the volume of business is sufficient, a revenue sufficient to meet their expenses and to pay for the use of the capital invested; and the further obligation of uniformity as to the ratio existing between the several classes for all citizens and for all localities. The classification and ratio of rates should be made uniform throughout the whole country. This could be easily done by establishing a "standard rate," which would be the uniform rate necessary to produce the required revenue, classification being abandoned, and calculating all other rates from this standard. When it comes to the third step the author thinks that the greatest good to the greatest number will probably result from fixing rates at a certain amount per mile, with uniform terminal charges. The rate per mile is to vary according to certain grand divisions of the country, but to be uniform in each division. Between competing points, but one distance is to be recognized in calculating the tariff, and that is the shortest distance, or the distance measured along a straight line connecting those points.

It will be seen from the foregoing that Mr. STICKNEY holds radical views on the subject. With many of them we can heartily agree, but the truth of others is not so apparent. It seems to us that uniform terminal charges would work disadvantageously to the local shipper, and this class of traffic aggregates a large proportion of the whole. The mileage rate has not been altogether successful in foreign countries. The plan overlooks the principle that the man who puts his money into a business should have the management of that business. We believe that the better plan would be to let the companies make the rates and to prevent deviations from those rates. Not to fix rates, but to prevent discrimination. Whatever view may be held, the book is well worth reading and consideration by all persons interested in the welfare of our transportation systems and the country which they serve.

Annual Report of the Water Department of Cincinnati for the Year Ending Dec. 31, 1890. W. P. SHARP, Superintendent and Engineer. Pamph., pp. 88 and numerous folding sheets of tables.

This report contains valuable tables of statistics relating to the various operations of the works for several years, and in some cases from 1839 to 1890, inclusive.

—*Water-Works Reports.*—The following annual reports have been received, the gentlemen named being superintendents unless otherwise specified: Andover, Mass., J. E. SMITH; Brookline, Mass , F. F. FORBES; Cambridge, Mass., H. NEVONS; Fall River, Mass., P. KIERAN; Greenfield, Mass., C. L. SMITH; Holbrook, Mass , E. J. CHADBOURNE; Holyoke, Mass., J. D. HARDY; Lynn, Mass., W. H. MESSINGER, Chief Pumping Engineer; Malden, Mass., S. M. ALLIS; Natick, Mass., J. W. MORSE; Randolph, Mass., E. J. CHADBOURNE; Rockland, Mass., W. R. GROCE; Weymouth, Mass., G. S. RIES; Woburn, Mass., P. C. CRILLY; Woonsocket, R. I., B. I. COOK; Danbury, Conn., C. B. MASON; Middletown, Conn., J. C. BROATCH; Binghamton, N. Y., D. FELTER; Buffalo, N. Y., L. KNAPP; Cohoes, N. Y., A. T. KNIFFIN; Norwich, N. Y., C. B. MARTIN, Treasurer; Poughkeesie, N. Y., C. E. FOWLER; Troy, N. Y., E. DOLAN; Asbury Park, N. J., G. H. COFFIN; Erie, Pa., B. F. SLOAN, Secretary; Lewisburg, Pa., C. DREISBACH; Richmond, Va., C. E. BOLLING; Roanoke, Va., F. J. KIMBALL, President; Rome, Ga., L. A. WAGNER; New Orleans, La., L. H. GARDNER; Henderson, Ky., J. P. WIGAL; Cincinnati, O., W. P. THARP; Cleveland, O., JOHN WHITELAW; Sandusky, O., C. A. JUDSON; South Evanston, Ill., W. F. SILVER; Wausau, Wis., P. RINGLE; Fairfield, Ia., J. N. HINKLE, Mayor; Colorado Springs, Col., E. FROST; South Denver, Col., HENRY DOMIRE, Water Commissioner; Truro, N. S., A. L. ARCHBALD, Engineer; Stratford, Ont., D. B. BURRITT, Secretary.

TRADE PUBLICATIONS.

—*The Edison-Lalande Battery.* Edison Mfg. Co., Orange, N. J. Pamphlet, 16 pp., cuts.

The elements of this battery are zinc as the positive and black oxide of copper, CuO, as the negative plates, suspended in a one-third solution of caustic potash. When the circuit is closed, the water is decomposed, the oxygen forming oxide of zinc with the zinc, which in turn combines with the potash to form a soluble double salt of zinc and potash, which dissolves as rapidly as it is formed. The hydrogen which is liberated by the decomposition of the water reduces the copper oxide to metallic copper. The cell has an internal resistance of only 0.025 of an ohm, and an electromotive force of 0 7 of a volt when on continuous hard work.

—*High Duty Pumping Engines.* The Holly Manufacturing Co., Lockport, N. Y. 8vo pamph., pp. 60.

This pamphlet contains very full records and statistics of the performance of the well-known Holly-Gaskell pumping-engines, which has in part been published before, but is in good part new.

SOCIETY PROCEEDINGS.

Association of Engineers of Virginia.—The rooms of this Association at Roanoke will be opened on June 1 and regular meetings will be held thereafter. Other associations are requested to exchange papers.

H. W. HEWBY, Secretary.

New England Railroad Club.—At the meeting on May 13 amendments to the Rules of Interchange were discussed by Messrs. Adams, Chamberlain and Marden, of the club, and Mr. Kirby, President of the Master Car Builders' Association. The proposal to substitute a summer excursion for the usual annual dinner was referred to the Executive Committee. The next meeting will be held on Sept. 9.

American Institute of Electrical Engineers.—The annual convention has been held this week in New York City. Prof. Alexander Graham Bell was elected president, to succeed Prof. Wm. A. Anthony. Messrs. T. D. Lockwood, Carl Hering, O. T. Crosby and Wm. J. Hammer were elected vice-presidents, and Messrs. F. B Herzog, Wm. E. Geyer, H. G. Townsend, Francis R. Upton, J. C. Chamberlain, P. B. Delaney, Horatio A. Foster and H. Ward Leonard were elected managers. Messrs. Geo. M. Phelps, treasurer, and Ralph W. Pope, secretary, were re-elected.

Civil Engineer's Club of Cleveland.—At the regular meeting, May 12, a vote of thanks was extended to Mr. Aug. Mordecai for his donation to the club of a crayon portrait of the late Charles Latimer, former President of the club. The Executive Board was instructed to incorporate the club under the laws of Ohio. The President appointed Mr. W. T. Blunt as member of the Permanent Committee on International Engineering Congress and Engineering Headquarters in connection with the Columbian Exposition of 1893. Mr. J. Ritchie read a paper on "Recent Advancement in Electric Engineering."

A. H. PORTER, Secretary.

Engineers' Club of Philadelphia.—At the meeting on May 2 the secretary presented, for Mr. George R. Ide, a paper descriptive of the Judson pneumatic system of street railways, as constructed and operated at Washington, D. C. This system comprises connected rotating cylinders lying below and between the rails of the track, and in line therewith, which cylinders are operated by compressed air engines placed at intervals along the line. The cylinders are mounted in bearings in a conduit, and are engaged or clasped by a gripping mechanism suspended from the bottom of the car. The grip comprises two pairs of disks mounted so as to have their axes turned in an approximately horizontal plane to any desired angle with the axis of the underlying cylinder. When the axes of the disks are parallel with the cylinder axis the car will remain stationary, but when turned to any proper angle therewith the car will be moved. The velocity with which the car is moved depends upon the angle of inclination of the disk axes to the cylinder axis, the speed of the cylinder remaining constant. The speed of the car increases with the angle up to about 60°. With the cylinder running in the same direction the car can be run forward, stopped or reversed by the mere change in the inclination of the disk axes, which inclination is under the control of the driver upon the car platform. The Judson system was described and illustrated in ENGINEERING NEWS, July 13, 1889.

The Institution of Mechanical Engineers.—An ordinary general meeting was held in London, April 31, May 1. A further report of the Institution's Research Committee on Marine Engine trials, was presented, and a paper on Lancashire boilers. The reading and discussion of the report occupied the whole of both evenings, so that the boiler paper was shelved until next meeting. Within the last few years this Institution has expended a good deal of the large fund which it has accumulated in prosecuting trials on various engineering subjects by means of research committees: and with excellent results. The Friction and Rivetting committees have done excellent work, and established an authoritative standard of practice in these important subjects. The labors of the Marine Engine Committee have perhaps been more onerous than those of the other research committees, for it is no light matter to make an exhaustive test of a marine engine, even when a ship has been obtained for that purpose. Four vessels have already been tried by the committee, the Meteor, Fusi Yama, Colchester, and Tartar. The vessel which was the subject of the trials, now under consideration is the Iona, a cargo steamer, or "ocean tramp." Although the committee had to take such vessels as they could get for the purpose, it happens that the selection has offered a very fair contrast, embracing types of steamships of varying qualities. The Meteor is a passenger vessel running between London and Edinburgh, and in her, fuel economy is naturally made a secondary consideration to speed. The Fusi Yama is an ordinary trader; the Colchester is one of the Great Eastern Railway Company's twin screw passenger boats running between Harwitch and Antwerp; the Tartar is a cargo steamer. We will shortly give the leading particulars of the trials of the five vessels above named, together with some remarks on this subject. The summer meeting of the Institution will be held in Liverpool.

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

Published Weekly at Tribune Building, New York.

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M. N. Baker, F. P. Burt, }
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Drawings and Photographs *of all new engineering works or designs, large or small, of interest from their magnitude, novelty, or originality, as well as newly adopted* **Standard Plans** *for engineering structures or details, rolling stock, etc., are always desired for early publication. Also* **Brief Technical Notes** *of the cost or manner of executing work, tests of materials, machines or other new devices, and* **News of New Construction** *of all kinds.* **Letters** *for publication must be accompanied by the name or card of the writer.*

COMING TECHNICAL MEETINGS.

Denver Society of Civil Engineers.—May 26. "Steel." Secy., Geo. H. Angell.
Civil Engineers' Society of St. Paul.—June 1. Secy., C. L. Annan.
American Institute of Mining Engineers.—June 2. Fifty-ninth Meeting, Cleveland, O. Secy., R. W. Raymond, 13 Burling Slip, New York.
Western Society of Engineers.—June 3. Secy., J. W. Weston, 230 La Salle St., Chicago.
Engineers' Club of St. Louis.—June 3. Secy., Arthur Thatcher, Room 801, Odd Fellows' Building.
Engineers' Club of Minneapolis.—June 4. Rooms, Public Library Bldg. Secy., F. W. Cappelen.
Technical Society of the Pacific Coast.—June 5. Secy., O. von Geldern, 819 Market St., San Francisco.
Association of Civil Engineers of Dallas.—June 5. Secy., E. K. Smoot, 803 Commerce St.
Engineers' Club of Philadelphia.—June 6. Secy., Howard Murphy, 1122 Girard St.
American Society of Swedish Engineers.—June 6. 250 Union street, Brooklyn, and 347 North Ninth street, Philadelphia.
Engineers' Club of Kansas City.—June 8. Rooms, Baird Building. Secy., H. Goldmark.
Civil Engineers' Club of Cleveland.—June 9. Secy., A. H. Porter, 50 Euclid Ave.
American Railway Master Car Builders' Association.—June 9. Annual Convention, Cape May, N. J.
Civil Engineers' Association of Kansas.—June 10. Secy., J. C. Herring, Wichita, Kan.
Engineering Association of the South.—June 11. Secy., Otto H. Landreth, Vanderbilt University, Nashville, Tenn.
Northwestern Track and Bridge Association.—June 12. Secy., D. W. Meeker, St. Paul, Minn.
American Railway Master Mechanics' Association.—June 16. Annual Convention, Cape May, N. J.
Engineers' Society of Western Pennsylvania.—June 16. Secy., J. H. Harlow, Pittsburg, Pa.
American Society of Mechanical Engineers.—June 16–20. Annual Convention, Providence, R. I. Secy., F. R. Hutton, 12 West Thirty first street, New York.
Boston Society of Civil Engineers.—June 17. Secy., S. E. Tinkham.
Engineers' Club of Cincinnati.—June 18 Secy., J. F. Wilson.

We call the especial attention of our readers to the note from Mr. L. L. Buck, which appears in another column, in regard to the reconstruction of the Verrugas Bridge, as described in our issue of 9th inst. In that description we failed to give due credit to Mr. Albert S. Riffle for his supervision of this dangerous and difficult work as resident engineer in charge, on behalf of Mr. L. L. Buck, the designer. We stated simply that Mr. Riffle was "Assistant Engineer for Mr. Buck," which was literally true, but by inference untrue, since it fails to adequately recognize the dangerous and delicate duties entrusted to Mr. Riffle, and the skillful and faithful way in which they were discharged. As is now pretty well known, not only is the structure itself a large and important one, but the valley which the viaduct crosses has an evil distinction in a horrible kind of fever which attacks almost every one who visits it, and which physicians have never yet been able to understand and vanquish, though Mr. Meigs in old days spent large sums of money in the effort to find some man or some kind of treatment which could do so. Mr. Riffle was attacked by this fever in due course, in spite of all precautions, as was Mr. Buck before him when resident engineer of the old structure, but in spite of this danger and cause of delay to himself and his men, he carried through the rebuilding of the viaduct with conspicuous ability and success in managing the work, ably seconded by Mr. Dougherty, the foreman in charge. We take especial pains to give proper credit where due for the execution of difficult works, and feel especial regret when we in any way fail to do so. We therefore take this mode of making the correction as prominent as possible.

The Monier system of concrete arch construction, which is described and illustrated in another column of this issue as fully as the experience so far acquired makes it possible to describe it, is especially worthy of the careful study of engineers, as it is one of the most promising of recent engineering innovations. It is possible that the principle on which it is supposed to be based, that of reinforcing the defective tensile strength of concrete by incorporating with it a coarse network of wires, is capable of still further extension, as, for instance, to reinforcing flat concrete floors for fireproof buildings, in which iron beams are buried, after the system which has been already quite extensively used abroad with remarkably good results, but which has been as yet but little used in this country. Be this as it may, for arches the Monier system may be said to be already a demonstrated success. The true theory of the system, or the way by which it really adds so much to the strength of an arch, we should be inclined to state a little differently from that given by its inventor and in the German descriptions from which our account is abstracted; in fact, it seems necessary to amend the stated theory in order to account for the immense addition to the strength of concrete arches which the device has been shown to give. No mere reinforcement of the tensile strength of the concrete would of itself account for this. That is a great factor, no doubt, but we suspect that a greater one is this:

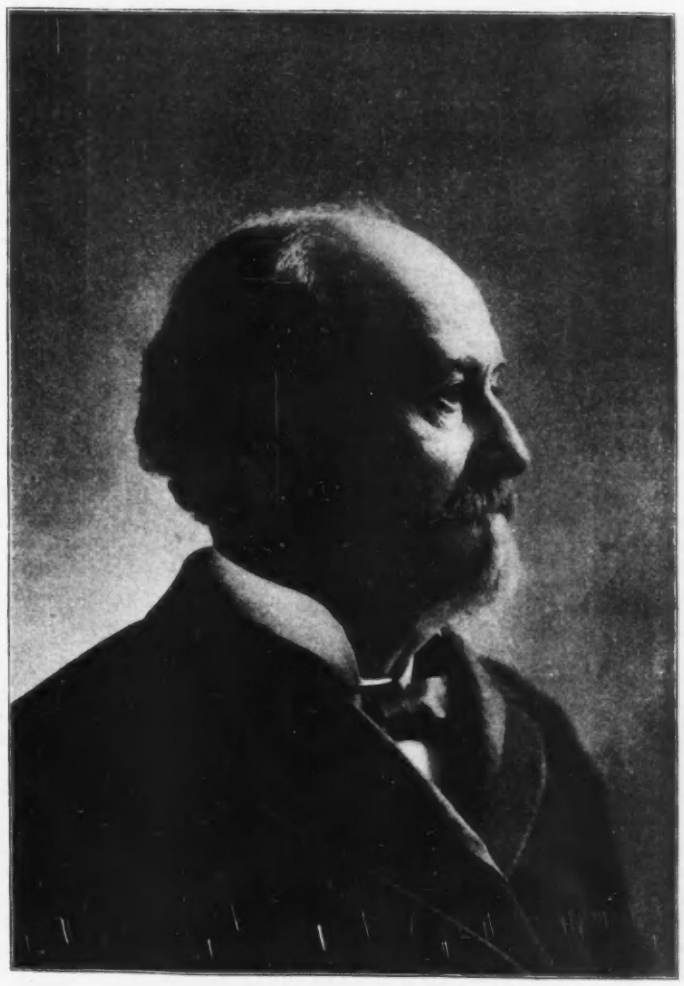
A sheet of paper or of metal has great tensile strength if *inequality* of strain, and especially all excess along the edges, can be avoided; but, given even a slight excess along the edge, and it tears, or fails in detail, under comparatively trifling stress. In like manner every masonry arch will fail in detail by the irregularity of stress resulting from even a trifling distortion, long before the voussoirs as a whole are carrying any load approaching their crushing strength. The failure begins by chipping upon (usually) the inner face of the arch, whence it spreads at once, and ends sooner or later in complete failure. Giving extra strength in any way *to the exterior faces* of the arch has a strictly analogous effect to that of hemming a piece of cloth or ribbing the edges of a sheet of metal; it makes tearing (or surface failure) very difficult where before it was very easy, and hence increases many fold the practical strength, though theoretically little or nothing has been added. It is the advantage of concrete that by an imbedded wire netting this extra surface strength can be added to it, while to masonry it cannot.

No other change of practice in engineering matters is now going on with such rapidity as the substitution of cable or electric power for horses in operating street railways. In our issue of Aug. 30, 1890, we gave the census figures showing that over *one-quarter* of the street railway mileage of the country was already operated by cable, electric or steam motor power, there being a slightly greater mileage of electric than of cable railways. In a recent bulletin, from which we abstract freely in another column, the reason for this great change may be in part seen, and seen with more fullness than has heretofore been possible in any impartial record. Not that these census records are to be implicitly relied upon or taken at their face value; a multitude of minor modifying conditions and imperfections of record must be considered and allowed for; but the main facts of a comparison between the three kinds of motive force, horses, cables and electricity, are pretty clearly shown.

The cost of running a car by horses (or mules) varies on 30 representative railways between 9.10 and 25.82 cts. per car mile; 5 roads showing less than 10 cts.; 6, 10 to 15 cts.; 7, 15 to 20 cts.; 12 over 20 cts. The cost seems to be largely independent of the volume of traffic, as might be expected, the average being 18.16 cts. The table indicates that 20 to 25 cts. per mile is about the cost with heavy traffic in large cities, and about 15 cts. the nominal cost with lighter traffic and in smaller cities.

Against this we have the fact that the cost of running cars by electricity (a single car run by storage batteries excepted) is in only 1 case out of 9 so high as 23 cts., 5 others averaging under 15 cts., and 3 others averaging under 10 cts.; the average for the whole 9 roads being 13.21 cts. against 18.16 cts. by horses. This, moreover, is for a very thin traffic on the electric roads, viz., only 36,300 car miles per mile of single track, against 69,500 on the horse roads, and 163,000 car miles on the cable roads. As the cost of the electric railways is only $46,700 per mile of *road* (not track) against $71,400 per mile of horse railway, and $350,300 per mile of cable railway, it is easy enough to see why electric railways are everywhere being built, in preference to horse railways, especially for thin traffic.

Comparing electric with cable motors, the broad facts are that electric railways show a slightly less cost per car mile (13.21 against 14.12 cts.), in spite of the fact that the cable railways have 4½ times as heavy traffic, viz., 163,000 against 36,300 car miles per mile of track. From this the inference is defensible that whenever the traffic the year round is less than about 500 cars per day over each track (*i. e.*, more than one minute apart during the busy hours) electric power is much cheaper than cables, unless the grades to be operated are very steep. The records afford no evidence that grades have any considerable effect to increase the horse-power required by cable lines; nor should they do so, since it is one of the advantages of cable railways that the power lost in going up hill is returned in going down hill. The electric railway records ought to show some effect of grades, but as a matter of fact they show very little, the line of steepest grades and heaviest traffic (No. 1) having 64 HP. per mile, against an average of 42 HP. for the five lines of heaviest traffic (1 to 5) and 27 H. P. for the four lines of lightest traffic. The traffic of all the electric lines is so much lighter than that of the cable railways as to make comparison difficult, but comparing electric railway No. 1 with cable railway No. 9, which have about the same volume of traffic (480,000 passengers per mile per year), the electric railways make much the best showing,



O. Chanute

13.5 against 18.6 cts. per car mile, and this is in fair accordance with the general tenor of the records. It is much to be regretted that two or three of the electric lines had not had a heavy traffic, so as to be comparable with the heavier cable lines; but on the other hand, there is no evidence in the tables that great volume of traffic materially reduces the cost of operating cable railways per car mile, as may be seen in the following comparison, which we deduce from the large table on another page:

Cable railway.	Av. length track, miles.	Av. cars in service at once.	I. H. P. of engines.	I. H. P. per mile.	Passengers yearly per mile.	Operating cost per car mile.	Cost, cts., per pass. carried.
Nos. 1–5....	13.76	69.2	1.595	116	2,005,000	14.46	3.11
Nos. 6–10....	14.73	47.4	1.055	71½	715,200	15.74	3.72

OUR esteemed contemporary, the *Engineer*, is suffering the penalty of its sins in being unable to get any one on this side of the water to pay serious attention to its requests for information as to American locomotives. As we have had occasion to intimate to our contemporary before, whoever garbles and misrepresents the arguments of an opponent in a controversy which he has himself invited, and which he is in honor bound to state fairly if at all, gains a certain cheap advantage for the moment, but pays the penalty in the end of being quietly ignored.

After suffering from our contemporary's practices of this kind until patience ceased to be a virtue in the effort to give it information which it had itself asked for, on a subject which excites little interest on this side of the water, we were compelled to give it notice that we could hold no further discussion with it, and it has since been trying with very poor success to induce other journals to enter into discussion with it, the only result being more or less good-natured chaffing. It now gives vent to the following almost plaintive wail, in which we take the liberty of italicizing certain phrases:

> American methods of controversy as represented by United States railway journals are, to say the least, peculiar. Months have elapsed since we challenged our contemporaries on the other side of the Atlantic to explain in what way the American locomotive was superior to the English engine. *We have had no hesitation in saying that the importance of the question for us lies in the fact that orders for locomotives are given to United States builders by our colonies, which orders ought to come to this country;* and they are given, as we believe, under a false impression, conveyed by the agents of American houses, that American engines are in every way better than those made in Great Britain. Statements of this kind are either susceptible of proof or they are not. *We have asked for proof, and not a shadow of it has been forthcoming;* we have tried all round to get at some facts, and the most prominent fact we have reached is that up to a very recent period our contemporaries knew nothing as to the working expenses of any American line. When we demanded information as to coal consumption, cost of haulage, mileage, etc., the only reply we received was that our contemporaries did not know, and that we were equally ignorant.

Esteemed contemporary, it was unnecessary to thus confess in cold type that you were really only playing to the galleries to influence the guileless colonist. It has long been but too apparent, and that is one reason why your requests for information are ignored, another being that you will not state fairly the information which is given you. No one cares to enter into scientific discussions with a traveling salesman. It is a mere waste of time. He is only anxious to make out a case, not to get at the truth, and the journal which confesses boldly that the true inwardness of its pretended scientific interest is not to see if English locomotive practice can be in any way improved, but to cause "the colonies" to buy English instead of American locomotives, places itself in precisely this category.

Irrigation Development in California and Europe.

To those who have attempted to solve the irrigation problems of the Western states perhaps the greatest obstacles encountered have been in connection with irrigation law, or the lack of it. Irrigation in this country has had a recent and rapid development, but in its earlier practice progress was slow and methods were old and faulty. The Spaniards in the Southwest and California and the Mormons of Utah were not the right class of people to make great progress either in the extent of their work or in its engineering perfection. Cheap labor also tended towards a slow development.

When an increasing population made irrigation on a larger scale a necessity it was found that the laws regulating the use of water were very inadequate, and that in some sections, notably California, the use of water for mining took precedence of all other purposes. In California both navigation and agricultural interests were threatened, and in some cases greatly damaged, by the débris from hydraulic mining brought down from the mountains to the lower levels of the streams. The courts were so crowded with cases involving disputed water rights and claims for damages that other legal business was often delayed and the water cases themselves dragged on slowly. As soon as the agricultural and commercial interests gained sufficient strength their efforts to lessen these difficulties by securing remedial legislation resulted, in 1878, in the creation of the office of State Engineer. The act creating the office ordered investigations designed to throw light on the subject of irrigation, water rights, damage to agricultural and navigation interests to aid in future legislation.

Mr. WILLIAM HAMMOND HALL, M. Am. Soc. C. E., was appointed State Engineer and held the office for some ten years until it was abolished two or three years ago. Other duties in connection with the office prevented a start on the irrigation investigations until the middle of 1881, after which time extensive examinations of irrigation works in California were made by Mr. HALL and his assistants. The work was greatly hindered by the uncertainty of the appropriations, and finally stopped from lack of money before its completion. Some of the work was carried through at the personal expense of the engineer. Two very valuable volumes, which we have previously referred to, and review quite fully in another column, are the results of this work, but we desire to give, in addition, a kind of bird's-eye view of the existing situation as revealed by these reports: As one of the principal objects of the investigation had been to secure and present information which should aid in framing laws regulating irrigation in California the first volume of the report consisted of a review of irrigation development in the three countries whose experience and practice would be most likely to guide California, viz., France, Italy and Spain. The first volume was therefore entitled "Irrigation Development," and as the countries named had once been under Roman rule, and were largely indebted to Rome for all their laws, the volume very properly opens with a brief review of Roman law regarding watercourses and rights. It then proceeds to give in detail the attitude of each government towards its streams and their use, the laws regulating the same and the general irrigation practice in each country, all of which is more fully outlined in the review of the report which appears elsewhere in this issue.

At no time in the history of America has there been a greater need than now of a comprehensive review of the irrigation laws and customs of countries where both have been continued through a long experimental period under circumstances which afford some basis of comparison with our own. For to-day irrigation is one of the greatest, if not the greatest, engineering and legislative questions before the people of the West, and it has an important bearing upon the welfare of the whole country. The future of irrigation depends more largely than is generally realized, West or East, upon the legislation of the states most directly interested, and upon the attitude of the general government. This being the case, the value of a well-digested presentation of the laws and practices of the three irrigation countries of Europe is obvious. The first part of Mr. HALL'S report is such a presentation and should be in the library of every one interested in irrigation and should be studied by all who are called upon to legislate on the subject, whether in the West or at Washington.

France, Italy and Spain being centralized governments, their attitude toward irrigation should be helpful in deciding the position which our general government should take towards irrigation. France maintains a rigid supervision over all streams, in the interest of the people as a whole, and grants subsidies to irrigation companies. In this country there are few or no advocates of government supervision of any except interstate streams, but there are many who urge that the government should lend its aid to irrigation enterprises, and the several states can learn much from foreign practice regarding the regulation of watercourses and the use of water.

The engineer may find Part II. of Mr. HALL'S report more interesting and useful to him than Part I., but we risk nothing in saying that Part I. is really the part of the report which will best repay study, for those who are in a position to influence legislation, and which is likely to do the most permanent good in unifying and perfecting our irrigation practice. The second volume treats of irrigation as practiced in San Diego, San Bernadino and Los Angeles counties, and is entitled "Irrigation in Southern California." Existing works are described in detail and several illustrations and some maps are given, all of which are referred to at greater length elsewhere. Undoubtedly this volume contains far more information regarding irrigation in this country, although limited to one state, than is to found elsewhere. It is presented in a form very convenient for reference, and seems sure to meet with a wide circulation. Nevertheless, until our irrigation laws are simplified and perfected, our irrigation practice can never be on as broad or as grand a scale as it will be in time, or so well repay study.

A third volume, entitled "Irrigation in Central California," treating of the counties in the San Joaquin Valley, is now being brought out, and a fourth volume, "Irrigation Questions," is projected. The demand for works on irrigation is now great and the supply small, Part II. of this report being the only extended presentation of American practice which has ever been published, so far as we know. The third and fourth volumes will be welcomed as soon as they appear, and it is hoped that other irrrigation engineers will be inclined and enabled to take up the work for other western states. With great good sense, which might well be imitated in regard to all our "Pub. Docs.," the reports are published in decent shape to look like other works, and sold like other works, by the state (to be obtained at $3 per volume from the Secretary of State), the only difference being that they are sold merely to partially cover the cost of publication and insure that they go only to those who really wish and will value them, instead of for profit. If sold for profit more than twice the price would be necessary to cover their cost. We repeat, however, that for the immediate present Part I. is worth all the rest combined to irrigation interests in enabling us, if we will, to study and profit by the lessons which others have learned in the dear school of experience, and not insist on going to it ourselves, as fools are said to do.

One thing is made abundantly clear by the facts narrated in Part I as to European practice and law, and the sooner this fact is recognized and acted on in our far western "arid area" the better it will be for it and for the country. Of all the great industrial interests of mankind irrigation is perhaps the least capable of successful development under the happy-go-lucky, devil-take-the-hindmost spirit of individual enterprise, which may be said to be the genius of our institutions, and which in other ways works so well. It will never work well in irrigation, as has already been recognized in part by our irrigation laws, but which must be recognized still more fully and completely before our irrigation interests are in satisfactory condition. Every country in Europe has in the earlier stages of its irrigation history been through much the same stage of irrigation development which we are going through now. Every one of them has been compelled to work its way out of it, and is now, with partial exceptions, well out of and beyond it.

All permanently successful irrigation practice on a large scale has been based, and must be based, on the primary assumption that the entire water supply belongs to the people, and must be managed in the interest of the people for the greatest good of the greatest number. No power of permanent control must be vested in natural or corporate persons except in strict accordance with this general theory, or trouble is sure to come. With mining, farming, manufacturing, even railroading, it is quite different. Their interests may safely be left to take care of themselves, on the every-man-for-himself principle, with only a moderate public supervision on special points, and good results, to a large extent the best possible results, are assured.

Not so with irrigation. The history of Spanish irrigation powerfully illustrates this. The Spanish water laws, like the Spanish mining laws, are perhaps the most perfect in form, if not in working, in existence, each having been finally developed into its present form by the conflicts of centuries, each now working admirably and equitably, and each being based on the general principle that ultimate ownership of all water or mineral deposit abides in the people or the king, and is only delegated to individuals on condition that it is for so long a time as the privilege is properly used. As respects mineral deposits, ownership does not go with the land, but whoever discovers and undertakes to work a mineral deposit has full rights of property in it so long as he works it, and no longer. If he abandons it, he loses membership, and it is open to any one else to "denounce" (as it is called) the mine and work it, the owner of the surface, as such, having in no case further rights in the deposit than to compensation for actual injury to or appropriation of the surface for mining use. Neither can any one, by payment of any sum whatsoever, acquire complete ownership in any mine. *Possession and use* give the title, which is absolute and unimpeachable so long as actual use continues, but lapses at once if a specified minimum use ceases. The precise form of the law varies in the different Spanish countries, and in some applies only to the precious metals, but its practical working is excellent and satisfactory, and we should be far better off if we had the same law, in the opinion of many good judges.

The irrigation laws have been even more broadly established on the same general principle, though of course the analogy is not very close as to details. Prior to the establishment of these laws there was great confusion and injustice in Spain in regard to the use of water, and the tangle of rights was all but inextricable, while the water was not used to nearly as much advantage as it might have been in many places. At last the Gordian knot was cut by asserting the state's right of eminent domain over all water courses. All running water was declared to be public property. All private rights were wiped out. Commissioners were appointed for each of the main valleys, who apportioned to each landowner the compensation to be allotted for the rights taken away and to be charged for the new privileges granted in lieu thereof, the whole being so managed as to involve little transfer of money in most cases, but to place the administration on an entirely different basis, under which there soon was, as there is now, contentment and certainty where there had been strife and endless litigation. It is a pity that we should have to go over again the same round of experiments which other nations have gone through before accepting the same conclusions, but accept them we must in the end, if universal past experience is any guide. Surely it is wise that we should do so without delay, so far as past Eurpean experience is applicable to our special conditions, and it is in making it easy to do this by collecting nearly all the necessary information in one volume, that it seems to us Mr. HALL'S report is likely to have its greatest permanent value, though all of it is of great value.

CORRESPONDENCE.

Formulas for Electrical Conductors—Correction.

Edison General Electric Co.,
NEW YORK, May 18, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I found in the table of formulas accompanying my paper, published in your issue of May 16, certain typographical errors made at this office. Will you kindly make the following corrections?

1. In the formula for power at motor pulley, which is

$$M = \frac{D \times \text{H P.} \times 1{,}600}{V \times e \times P},$$

the number 1,600 in the numerator should be 16,000.

2. In the definition of G, read "delivered *to* conductor instead of "delivered *by* conductor"

H. WARD LEONARD.

The Verrugas Viaduct—Correction.

NEW YORK, May 14, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: The article on the Verrugas bridge, which appears in your number of 9th inst., is unjust to Mr. ALBERT S. RIFFLE, whom I selected as Engineer in charge of contruction, and who had the responsibility pertaining to the position. Mr. RIFFLE remained on the ground during the entire time the work was going on, and he and Mr. DOUGHERTY (his foreman) took all the risks of losing their lives by the fever which prevails there, doing their duty thoroughly.

Mr. P. A. FRASER was Superintendent of the railway, but the credit of the successful preparation of the foundations and of the erection belongs to Mr. RIFFLE, shared by his foreman H. H. DOUGHERTY. I sincerely trust that you will give this correction a conspicuous place in your columns.

L. L. BUCK, Engineer Verrugas Bridge.

[We do so with pleasure, regretting that the information in our hands from other sources led us to do this injustice to Mr. RIFFLE and Mr. DOUGHERTY.—ED. ENG. NEWS.]

Canadian Pacific Railway Standard Trestle Plans—Correction.

MONTREAL, Ont., May 13, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I find in ENGINEERING NEWS of May 2 what purports to be a description of the wooden trestles the Canadian Pacific Railway Co. used on its line across the State of Maine. The structures as described and illustrated are not in any sense the standard structures of this company. Practically all of our truss and trestle bridges in our line across the State of Maine are in masonry and iron, and if any such timber structures as that described was used in the original construction, it was designed to meet local conditions as to the size of the timber obtainable, and I am at a loss to know how such plans came to be published as our standards in a journal usually so careful and correct as the ENGINEERING NEWS.

P. ALEX. PETERSON.

[They were furnished to us along with a considerable series of drawings of other standard details, which we have already published, by an engineer formerly engaged on the work. We presume the facts are as to this particular design that it was used in some few cases, but that we failed to give a correct idea of how little it was used, from lack of knowing that fact.—ED. ENG. NEWS.]

The Form of Rail Sections.

LEXINGTON, Ky., April 27, 1891.

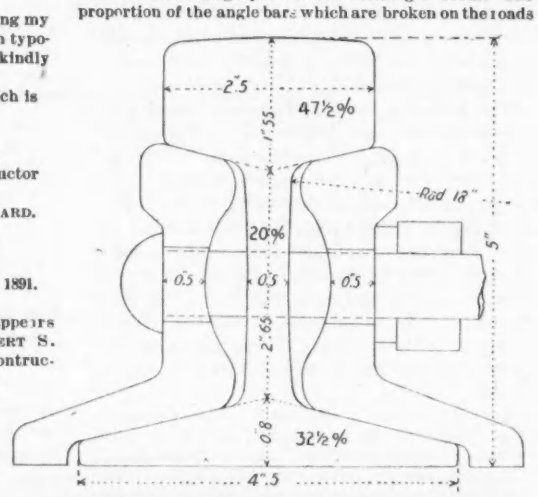
TO THE EDITOR OF ENGINEERING NEWS:

SIR: I inclose a section of a 75-lb. steel rail and joint for the same, to which I will ask your attention.

I think it a mistake to make the rail as wide as it is high, which has been and is too common in practice. This might do very well if the rails would always keep the same shape. I think it better to make them about as much higher than they are wide, as they will wear away when worn out. The object of this is to gain strength in the rail and the joint, and to put more of the metal in the head, and give a larger per cent. of the consumable part of the rail.

In the section here given there is 47½% of metal in the head, instead of 42½%, as shown in the average sections given in ENGINEERING NEWS of March 21. Now, supposing each of these patterns is worn until the head had only 20 lbs. of metal remaining. The average rail, which your committee seems to favor, would have endured a wear of 11.1 lbs., while the pattern here suggested would have furnished 15.6 lbs. of metal—which is 40% more than the other. The stem is only ½-in. thick, which is heavy enough, as you hardly ever find any failure in the stem of that thickness.

Giving the rail a little extra height is a great gain for the joint if it be made of angle bars. These splices all have to be weakened by having holes through them for the bolts, and they are generally so narrow that but little metal is left above the bolt holes; and this has a sharp top corner where a large part of the breakages occur. The proportion of the angle bars which are broken on the roads



A SUGGESTED 75-LB. RAIL SECTION (Half Scale).

of the country is frightful. This joint is enlarged in the top to give a rounded top corner and increase the metal to avoid these breakages.

This joint is more than *three times* as strong as the ordinary angle bars used, with a 60-lb. rail, and fully twice as strong as the best which are used with rails of that weight. With the present cheap prices for steel rails and the heavy rolling stock and high speeds we use, this rail is about as light as any railway ought to use, while I doubt if there is very much economy in making them much heavier than this.

These joints should be made about 30 to 36 ins. long, with 4 bolts suspending the joint between 2 ties. When the large joints are used with 6 bolts and a tie under the joint it is the natural tendency of the ordinary trackman to pack the tie under the joint. If this is well packed and the adjoining ties not quite so well sustained, when a heavy driving wheel comes down on each side of the joint, it breaks the angle bars in the top just as it does in the shorter splices.

W. A. GUNN.

[Our correspondent's angle bars are designed in general accordance with present tendencies and accepted theories, but not so his rail section in one important respect. The primary necessity in a rail is that it shall be of good, tough, well-consolidated material; and if this be not obtained, the proportion of the metal in the head does not much matter, for it will mash out of shape any way. Now it has at last been ascertained, after loss of millions in rolling bad sections, that with a heavy head and thin neck and base, the rail must be rolled so hot, in order that the thin parts may not cool off too quickly, that the head has hardly any work done in it by the rolls, and comes out nearly white hot, while the rest of the rail is comparatively cool. *Therefore*, the present tendency is to thicken the neck and base and

broaden and thin the head, in order that the rail may be rolled cooler, may all cool off together, and may be all well compressed by the rolls. It is so perfectly obvious that very little metal is needed in the neck or base and that (within reasonable limits) the more metal in the head the better, *if of equally good quality*, that it may easily be seen that other motives have lead to thinning and widening the head and thickening the neck.—ED. ENG. NEWS.]

The Monier Method of Constructing Arches.

The Monier system of arch construction, as practiced by the Monier Construction Co., of Berlin, and its branches in several other cities in Europe, is a novel and interesting departure in arch designing. We have already noted tests of a Monier arch in our issues of Feb. 1 and Aug. 2, 1890. These experiments were made at Matzleindorf, near Vienna, for the

Fig. 1.

Southern Railway Co. of Austria. Their main details were as follows:

The arch, as shown in the accompanying outline cut, Fig. 1, was 32.8 ft. long, 13 2 ft. wide, and had a rise at the center of 3.28 ft. It was 6 ins. thick at the crown and 8 ins. at the abutments, and constructed of Portland cement, concrete and wire netting, as described below. The tests were begun by placing a locomotive weighing 40 tons over the crown, and after running this off, placing a 53-ton locomotive over a half of the arch. Then a half of the span was loaded with 110 tons of rails, equivalent to about 1,000 lbs. per sq. ft. The maximum deflection then observed was 0.12 in., and on the following day the arch had nearly recovered its normal position. A load of 188 tons of rails was then placed on half the span. This weight caused the abutments to give way, and on increasing its amount to about 2,000 lbs. per sq. ft., the arch sank without, however, entirely breaking.

These experiments were so successful that Herr FERDINAND HOLZER, Engineer of the Southern Ry., decided to rebuild a number of highway bridges over the lines under his charge in this manner. From an article by him in the *Wochenschrift des oesterr. Ingenieur und Architekten Vereins*, the following cuts and description of the construction of these arches are abstracted.

The principle of the Monier system is simplicity itself. A flat arch breaks, usually, near the center, the bottom layers of the arch being unable to withstand the tension to which they are subjected when heavily loaded. To remedy this, wires are run in the concrete from abutment to abutment near the soffit. The cement adheres to these wires, and the ultimate tensile strength of the lower part of the arch is thereby greatly increased. The system is still in process of development, and no satisfactory formula for computing the strength of such structures has yet been developed, or at least made public. Certain attempts in this direction have been made, and they correspond fairly well with the experience so far acquired, but that is too limited to make it seem expedient to even reproduce the formulas.

In Figs. 2 and 3 are given the general dimensions of one of the reconstructed bridges. The original structure was a 3-arch brick bridge, and was removed with some difficulty, owing to the number of trains passing under it. The centering employed had few novelties, and is shown in plan in Fig. 3.

The arches were built by the Vienna branch of the Monier Construction Co., of Berlin. The cement for the arches proper was formed of 1 part Portland cement and 3 parts of clean sand, while the concrete was formed of 1 part Portland cement, 4 parts clean sand, and 6 parts broken stone. The materials were worked up in two Amann concrete mixers.

While the concrete was being prepared, the network of wires was woven on the centering. The wires were of iron, 0.39 in. in diameter when running from abutment to abutment, and 0.28 in. when at right angles to these. The network was continued nearly 24 ins. beyond the face of each abutment, as shown in Fig. 4. Twelve wires per meter were used in both directions. They were thus about 3¼ ins. apart. The network was woven as follows:

The position of the wires was marked on the centering, and one of the smaller wires lightly tacked at every meter mark. The transverse, or larger wires, were then laid on these, the same distance apart, and tied to the others with fine wire. Over these were laid another set of small wires, also a meter apart; over this layer a set of larger wires, and so on until the net was completed, each intersection being loosely tied with fine wire.

The completed net was then raised to the proper height, 1.9 in., from the centering by placing flat stones under the intersections. Cement was spread over the centering from the abutments toward the center, and struck lightly with an iron trowel until its surface was covered with a film of water. The center layers were spread more thickly and tamped with light iron tamping-bars. At a distance of 9.5 ins. from the soffit, two more nets were laid. These started in the abutments, 24 ins. back from their faces, and extended for a distance equal to an eighth of span toward the center, as shown in Fig. 3. Over these nets another layer, 1.9 ins. thick, was spread and worked to the proper consistency with broad iron trowels.

The upper nets are designed to take up the tension in the upper part of the arch when one side of the span is heavily loaded. They are usually omitted, however. In September, 1890, the bridge was tested and pronounced perfectly safe.

This system of constructing arches is quite extensively used in buildings in Germany, Austria and Switzerland, but its extension into the field of bridge work is comparatively recent. There are a few bridges in Austria and Hungary, and in Bremen there is a large exhibition span constructed in 1890.

In Switzerland, the first bridge of any size constructed after the Monier system was built in the autumn of 1890. It is in the yards of the cement works of Zurlinden & Co. at Wildegg, and its general appearance is shown in the accompanying cuts taken from the *Schweizerische Bauzeitung*. It crosses an industrial canal at an angle of 45° and has a total span of 122.1 ft. with a rise of only 11.5 ft., so that the ratio of the latter to the former is 1 : 10.6.

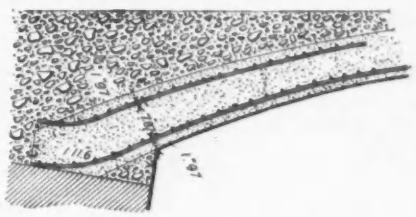


Fig. 4.

The bridge is 12.8 ft. broad. The Monier arch proper is 7.9 ins. thick at the center, and 25.6 at the abutments. The spandrel-walls were likewise constructed on the Monier principle and are connected at each end by two ties. The abutments are of concrete, and a backing of this material is run up the arch for some distance, as shown in the cuts. The right abutment was made considerably stronger than the other on account of the bad condition of that bank.

The bridge was required to support a uniform load of 34 lbs. per sq. ft. Since the structure is only intended for light wagons and pedestrians, this load will probably never occur. The tests of the bridge were made on Nov. 14, 1890, by Herr METZGER, President of the Zurich Engineers and Architects' Union, and a number of other well-known Swiss engineers.

It was decided to subject the bridge to a more severe test than that prescribed by Zurlinden & Co., and accordingly only one half of the structure was loaded at a time. The tests were made with the following loads:

1. Three empty carts; weight in all, 3,960 lbs.

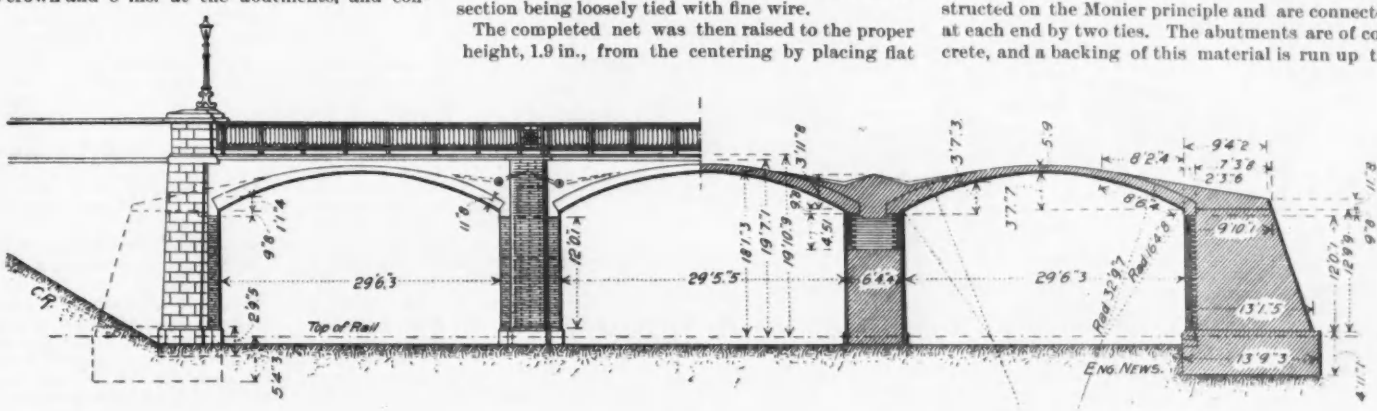


FIG. 2.

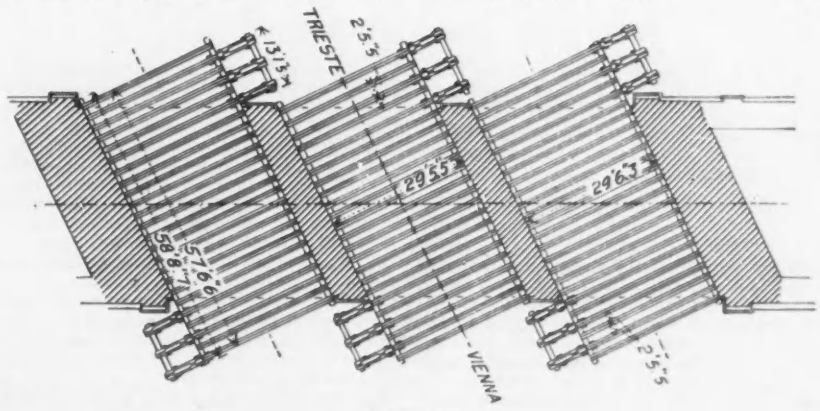


FIG. 3.

2. One empty and 2 partly loaded carts; weight, 13,400 lbs.

3. Two loaded carts, 9 horses, 8 men; weight, 26,500 lbs.

4. Four loaded carts, 9 horses, 12 men; weight, 40,000 lbs.

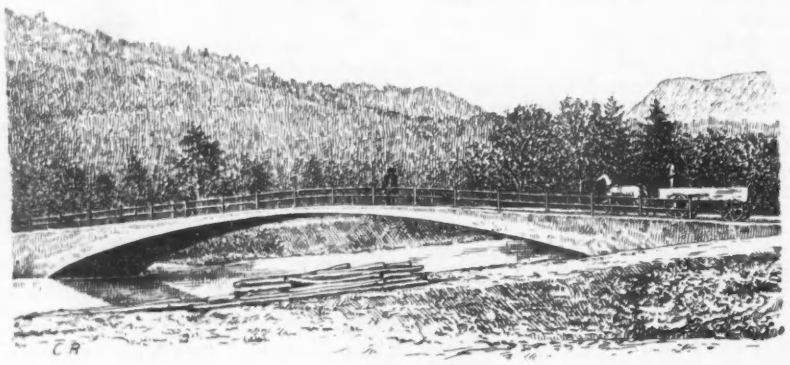
Levels were carefully taken before and during these tests on 11 points on the bridge and the abutments. It was found that with the heaviest loading the settling or lifting never exceeded 0.16 in.

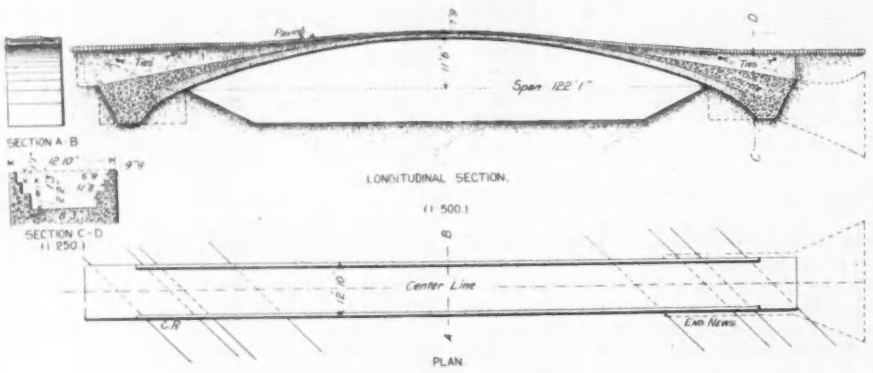
Before the bridge was tested, three small cracks of 0.04, 0.08 and 0.12 in., respectively, were found in the arch proper and a barely perceptible crack in one of the abutments. These were not enlarged during the trials and no new ones have since appeared.

In order to test the stiffness of the arch, 4 horses, drawing a sand cart, a total weight of 11,900 lbs., were driven over the arch, and it was impossible to detect any motion whatever during their passage.

This new system of arch construction has features of great promise, entitling it to careful study and further experiment to determine the precise limits of its efficiency.

Since writing the above, we have been informed that Mr. PHINEAS BALL, M. Am. Soc. C. E., has used wire netting imbedded in Rosendale cement to form flat slabs for flooring. This floor has been very satisfactory, as will appear from details which we shall give later.





MONIER ARCH AT WILDEGG, SWITZERLAND.

Vertical Lifts for Canals.*

(Concluded from page 441.)

A dock for ocean vessels in San Francisco, the floor of which is carried by 36 cylinders of 29.5 ins. diameter, provided with this valve gear, has, according to a communication in the *Centralblatt der Bauverwaltung* for 1888, page 158, given excellent satisfaction.

The design shown in Fig. 8 resulted from the endeavor to reduce the cost of construction in canals whose business does not require the use of two lock-chambers side by side, by using lifts with only one lock-chamber, and also from the desire to simplify the lifting apparatus as much as possible. In such a design the fundamental idea of the hydrostatic balance had to be abandoned, while, on the other hand, the use of one chamber with a plunger operated by water pressure would have been uneconomical in operation. An idea suggested in the *Wochenblatt für Baukunde*, Nos. 61 and 63, 1887, was developed, and this led to the solution now presented, a patent for which has been applied for.

The lock chamber *a* moves in four guides *c*, and rests by means of 27 columns upon 2 hollow cylinders *b*, which float in a pit filled with water. The buoyancy of these cylinders is such as to balance the weight of the movable parts, including that of the water in the lock chamber. The water surface in the chamber at the upper end of the lift is 3 ins. below that in the upper level of the canal, and at the bottom of the lift it is 3 ins. above that of the lower level. The motive power is obtained by increasing or diminishing the quantity of water in the chamber as may be required. This makes the consumption of water for one lockage about 176.5 cu. ft.

The movement is regulated by 4 water-pressure cylinders *b*, the plungers of which are firmly connected with the lock-chamber. The spaces above and below the chambers are filled with water and connected by a pipe provided with a valve. By means of these the opening through which the water, under the pressure of the plungers, must flow, may be increased or diminished so that the movement of the plungers and hence that of the lock-chamber may be regulated or entirely prevented.

While in motion, the horizontal position of the lock-chamber is maintained not only by means of the contrivance just described, but also by means of 2 wire ropes, stretched tight and passing over the 4 rollers *e*, fastened to the columns on both sides of the lock-chamber. The vertical portion of these ropes is made fast to the chamber at two points *f f* at the same level. Hence any tendency of one end of the chamber to move faster than the other necessarily forces the latter to keep pace with it. It must be noticed that this rope bears no portion of the weight of the chamber, but is to be regarded merely as a part of the guiding apparatus. The valve-gear is controlled by a man standing at *g*. Here are placed the handles controlling the valves in the system of pipes which connects the upper and the lower spaces of the cylinders *d*. Interruptions to the working are prevented by return and safety valves. A reservoir at *g* serves to equalize the spaces above and below the piston, and thus to compensate for the space occupied by the piston-rod.

The cylinders and piston-rods are so proportioned as to be quite moderately taxed in ordinary service. In case of repairs, accidents or any irregularities of operation, these cylinders also serve, by the use of water at high pressure, as powerful lifting apparatus.

The lock-chamber and the ends of the two levels are closed by gates operated by hydraulic pressure.

The ends of the lift-chamber are inclined to the vertical at a small angle, and the end of each level is formed by a short movable wedge-shaped section, the vertical sides of which form prolongations of those of the canal, and correspond also with those of the lift-chamber. But the end of the wedge next to the lift-chamber is inclined to the vertical at the same small angle as is the end of the latter, while its opposite end is vertical, as is also the end of the canal section proper, against which it abuts. This wedge is movable vertically, and thus permits the formation of a water-tight joint between each canal section and the lift-chamber, notwithstanding variations in the height of the latter. As in the design of C. HOPPE, the lifting speed is 4 in. per second, so that with a lift of 52 ft. the time actually expended in lifting is 2⅓ minutes, and the total time for one lockage about 15 minutes.

By reason of the great length of the floats *b*, the lock chamber is uniformly supported throughout, and can therefore be of light construction. This, however, necessitates a long pit which, if the depth is also considerable, forms an important part of the apparatus. The most advantageous method of arranging the pit should be determined in each case by the nature of the ground. Our figure is to be taken only as giving a general idea. The water surface in the pit must be lower than that of the lower level, as otherwise the descent of the lock chamber would be stopped by its buoyancy upon immersion in the pit, and before reaching the proper point. The pit must therefore be sufficiently water-tight to allow of maintaining this difference of level.

For moving the boats into and out of the chambers, hydraulic capstans are proposed. These, as well as the other hydraulic apparatus, take water from pumps and accumulators operated by steam engines.

According to the following estimate, the cost of the single lifting apparatus will reach about $291,000.

1. Lock chambers with floats and columns, guide ropes and valve-gear cylinders, with their appurtenances, gates and lifting apparatus	$161,000
2. Compound portable steam engine of from 30 to 39 HP., force pump with 2 accumulators, 4 capstans, sundries	14,000
3. Excavating pit, earthwork and masonry	116,000
Total	$291,000
Of which, for ironwork	175,000

With 2 lock chambers of equal dimensions, side by side, the items under 1 will be doubled, those under 2 will not be materially increased, while the excavation of the pit will cost but about one-third more; so that the total cost will reach about $500,000, as per the following estimate:

1. Two lock chambers with floats and appurtenances	$323,000
2. Portable steam engine with appurtenances	18,000
3. Excavation of pit, earthwork and masonry	155,000
Total	$496,000
Of which, for ironwork	340,000

VII. *Conclusions.*—The designs described in the foregoing, and represented by firms whose names are sufficient guarantee of successful working, would seem to demonstrate the applicability of vertical lifts to the German canals with their great dimensions.

Which of the two designs, that of HOPPE or that of GRUSON, is preferable in any given case must require a thorough-going study of the conditions.

If a very large business is to be expected for the projected canal, 2 lock chambers side by side would be preferable, and in such cases the adoption of the HOPPE design would most likely be advisable, for its cost of construction ($100,000) is less than would be the case for 2 lifts on the GRUSON principle. In this connection, however, it must be borne in mind that, as already shown, 2 lifts side by side on the latter principle will cost much less than 2 separate lifts, since the cost for the pit and for the guides, etc., would not be doubled; and they have this advantage, that they may be operated independently of each other, so that one lift may be thrown out of operation for repairs. Furthermore, in the GRUSON design the cost of 2 lock chambers side by side may be also reduced by making them of different sizes. It is necessary only to adapt one of the chambers to the very largest boats, while the other need only be of sufficient dimensions to receive the largest boats used in the normal traffic. Finally, it is of practical advantage in construction, that first one lock chamber may be constructed and afterward the other.

But, on the other hand, it may become desirable, in difficult ground, to avoid the excavation of the large pit, and in such cases the HOPPE design will be preferred, since it requires much less difficult excavation, and less of it.

The entire separation between the lifting apparatus and that for regulating the motion seems to be an advantage of the GRUSON design. Thus, while the lock chambers with their floats, both consisting wholly of large members, operate as a whole, the 4 hydraulic cylinders, necessarily containing more delicate parts, serve only to regulate the motion. Hence, in the GRUSON design the finer parts may be furnished in the smaller dimensions usual in machine work. But it must be borne in mind that in the GRUSON design, also, the pressure cylinders and the valve gear must be designed to withstand great stresses, as they are in the design here presented; for if the lock chamber should be suddenly emptied, the buoyancy of the float would act with enormous force.

Both designs have the following advantages over a series of ordinary locks:

1. The first cost is light. At La Louvière the vertical lift showed a saving in construction of 25% as compared with a series of locks for one boat each and with 9.84 ft. lift. For the purpose of comparison we may assume that 4 ordinary locks 239 ft. long, 29.5 ft. wide, 8.2 ft. draft of water and 11.5 ft. lift are replaced by one lift of 52.5 ft. instead of 46 ft. The cost of an ordinary lock will be about $100,000, from which we have:

4 locks, cost	$400,000
1 vertical lift, HOPPE design, costs	333,000
1 lift, GRUSON design, costs	291,000

* An address delivered before the Centralverein zur Hebung der Deutschen Fluss-und Kanalschiffart, by OSCAR W. PETRI, Königlicher Regierungs-Baumeister in Madgeburg.

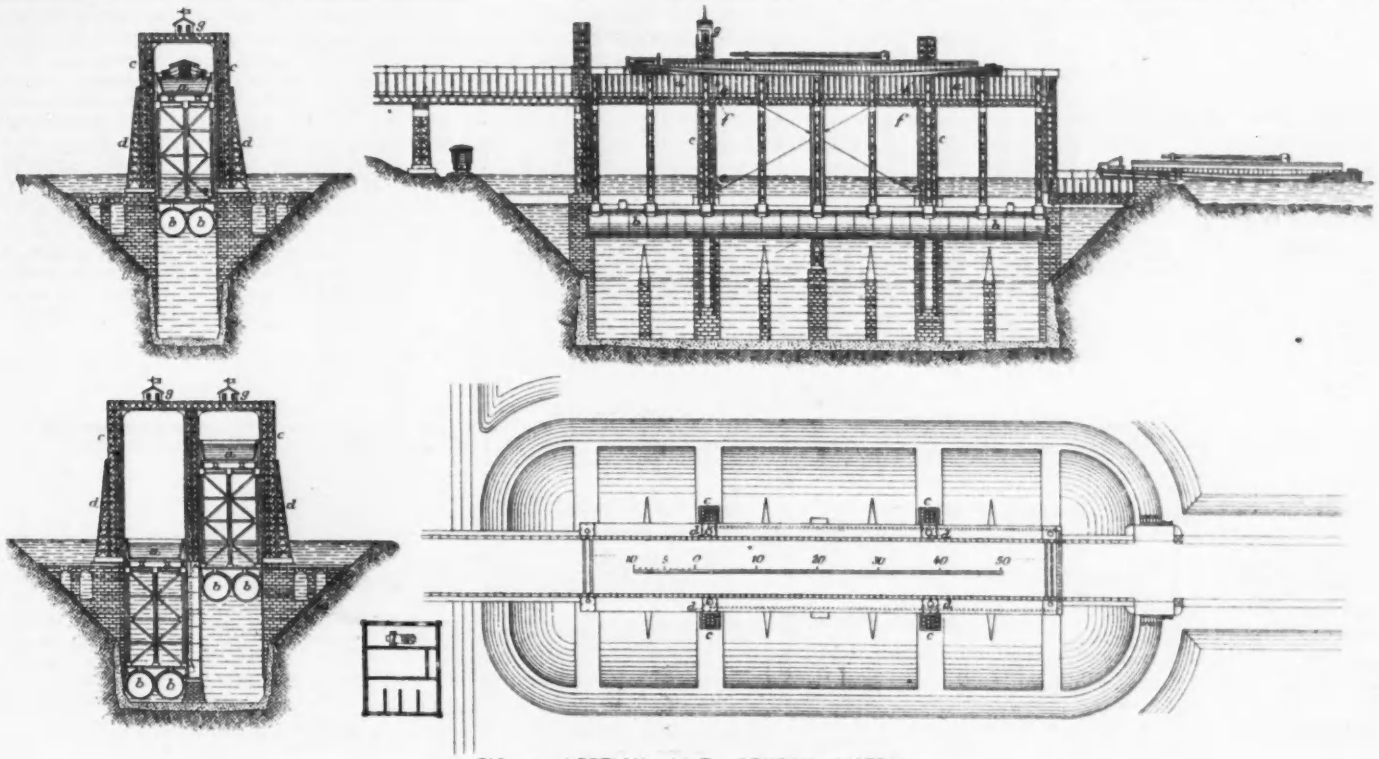


FIG. 8. VERTICAL LIFT, GRUSON SYSTEM.

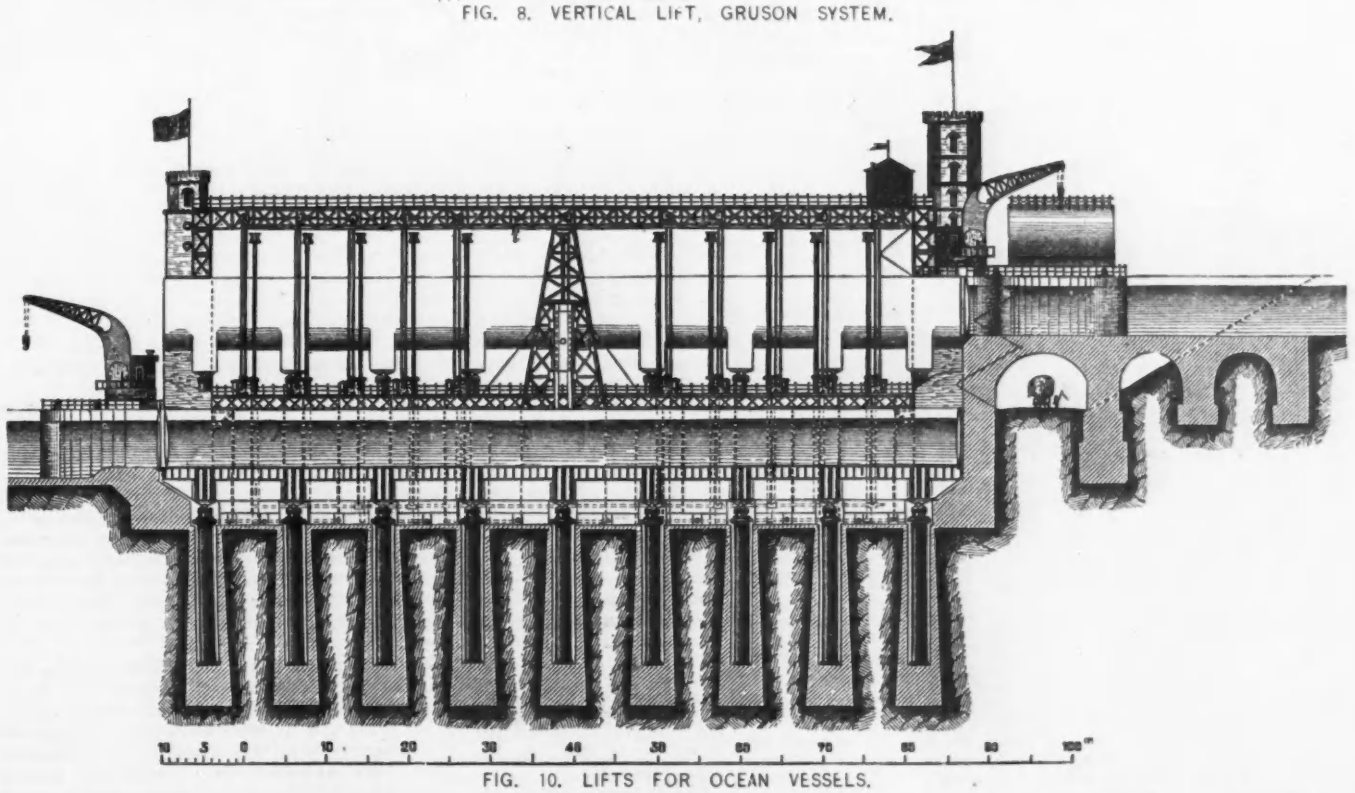


FIG. 10. LIFTS FOR OCEAN VESSELS.

The comparison thus results very favorably for the veritical lifts, especially when the construction of the HOPPE design as a double lock is taken into consideration. Besides, we have taken a height of lift 6.6 ft. greater than that of the series of locks. It thus becomes possible to locate the upper level, which we may assume to be the summit level, 6.6 ft. higher. Since this level is perhaps always in excavation the result will be, especially when the excavated earth is suitable for embankment, that a long summit level, with the descents grouped together at its ends, can be constructed without greater cost than a series of shorter levels with locks distributed among them.

2. The cost of operation cannot be accurately determined until reliable experience has been had with lifts of great dimensions. That they will be light is apparent from the results obtained at Anderton, where the annual expenses are about $5,000.

3. The rapidity of operation is shown by the following:

The delay for 4 locks at 20 minutes each, is	80	minutes
" " " 1 vertical lift	" 15	"
Saving	65	minutes

4. The long levels, obtained by concentrating the descents, are favorable to economy in the towing service. It is better not to pass the steamers through the locks, but if possible to arrange a separate towing service upon each level. As to the choice of steam tows, it is important to note that rope or chain towing is not well adapted for still water. Screw steamers of from 50 to 100 HP. are to be preferred, since there is abundant depth of water. One of these can tow from 2 to 4 of the largest boats.

5. In other cases the small consumption of water will appear as the greatest advantage of the vertical lift. Indeed, when more loaded boats go down than up, the vertical lift helps to feed the summit level.

In view of these important advantages of vertical lifts, an extension of their use appears highly desirable. We have seen, from a consideration of the Elbe-Trave, Oder-Spree, and Elster-Saale canals, that the conformation of the surface in Germany is favorable to a concentration of the descents. As first fruits of the designs here described, we may note that the memorial of the Leipzig Canal Association to the Government of Saxony of Jan. 26 1888, respecting the construction of the Elster-Saale Canal, was based upon the adoption of a vertical lift. Further applications of such lifts will suggest themselves upon a study of the line with reference to this feature, especially if, in locating the line, it is decided to concentrate the descent in place of endeavoring, as now, to place the locks as far apart as possible in order to avoid the occurrence of short reaches, the levels of which are seriously affected by the operation of lockage at their ends. Of course it is not suggested here that all locks should be replaced by vertical lifts. The use of the latter will naturally be confined chiefly to broken country.

The canal of the future will no doubt have a long summit level terminated by vertical lifts. In the gentler slopes descending to the plane, ordinary locks will be in order, for the cost of vertical lifts for small heights becomes too great. It is a fortunate coincidence that the farther we go from the summit level the less serious becomes the question of water consumption by locking.

Even in cases where the summit level is abundantly fed from natural streams or by drawing from contiguous water-sheds there is much to be said in favor of mechanical lifts. Their use renders it possible to materially red uce

the expenses of operating the canal, for the levels then may be utilized as great collecting reservoirs. Turbines may be set up at the lifts, for employing the water power and their work distributed to manufacturers, increasing industrial enterprise in their vicinity.

In a report to the Fourth International Congress on Inland Navigation, held at Manchester, England, July, 1890, Mr PETRI described two still more recent designs by O. HOPPE. We are indebted to the *Centralblatt der Bauverwaltung* for the greater part of the following matter concerning them.

In one of these, each chamber is supported by 6 plungers, as shown in plan in Fig. 9. This modification is designed to obviate the objection that under so large a lock chamber as would be required on the German canals, 2 plungers would hardly afford the necessary security.

These 6 plungers are designed to carry 1½ times the total load carried where only 2 plungers

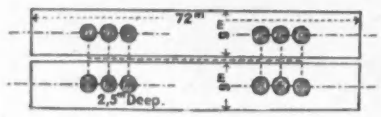


Fig. 9.

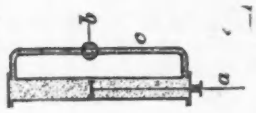


Fig. 14.

Referring to the GRUSON design, above described, in which the weight and load of the chamber, instead of being balanced by that of a second chamber, as in a hydrostactic balance, is carried by a single long cylindrical float, Mr. PETRI remarks that in difficult ground the expense of the long float-pit may be obviated by substituting for the single long float a number of smaller ones with vertical instead of horizontal axes. This gives, instead of a long ditch, a series of cylindrical wells which are more readily excavated and made water-tight. On the other hand, this arrangement necessitates an increase in the weights of the moving parts, since the load is less uniformly supported.

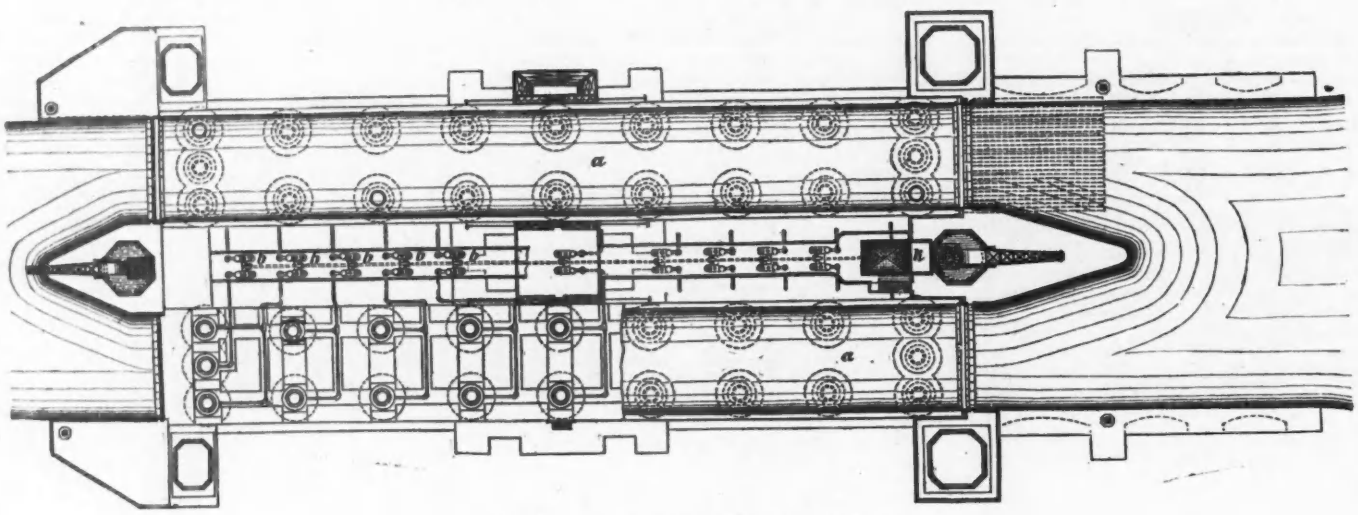


FIG. 11. LIFTS FOR OCEAN VESSELS.

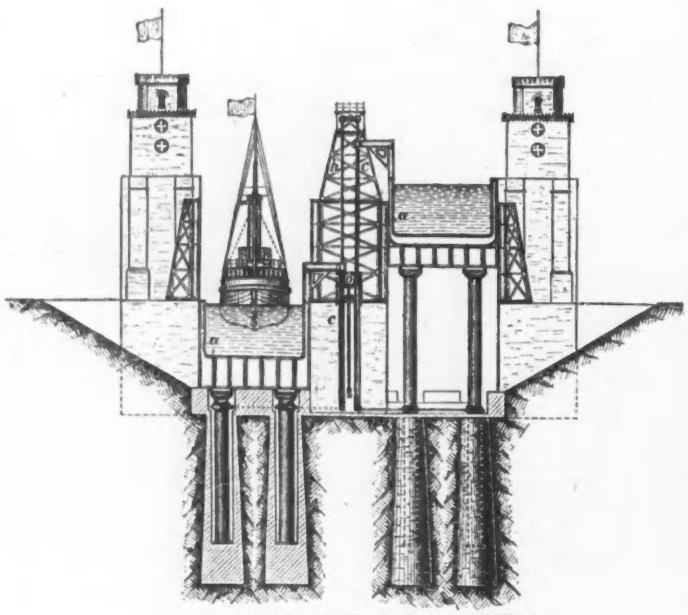


FIG. 12. LIFTS FOR OCEAN VESSELS.

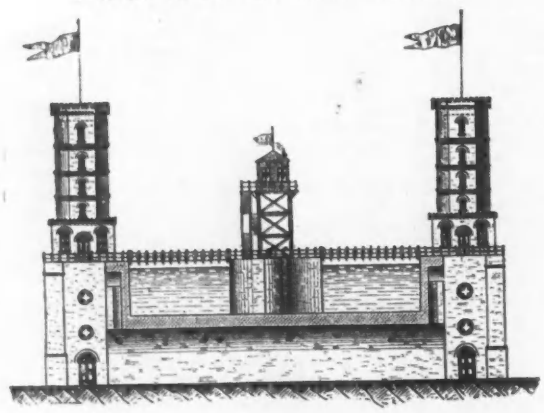


FIG. 13. LIFT FOR OCEAN VESSELS.

are employed under each chamber.

In the other design, intended for ocean vessels, and shown in Figs. 10-13, each chamber is supported on 20 plungers. The cylinders are arranged as shown in plan in Fig. 11, each pair of opposite cylinders having a common valve-motion: but additional cylinders, with separate valves, are provided at the end to support the end of the chamber in case the other 2 end cylinders should fail to work.

In Fig. 12, it will be noticed that in order to admit ocean vessels with masts, the overhead lateral bracing between the upright guides is omitted; and cranes are provided for lifting and lowering the gates and transferring them from side to side, as in Figs. 10 and 11.

Guide frames placed at the middle of the length of the chamber resist longitudinal and lateral pressures, while horizontal rotation is prevented by 4 guides at the corners. These are so arranged as to give room for expansion and contraction under changes of temperature.

Each chamber is 312 ft. long, 41 ft. wide, and with 21 ft. 4 ins. of water, holds 8,400 tons. The chamber itself and the plunger weigh together 3,000 tons. Hence, with the 20 plungers 59 ins. in diameter, the pressure in the cylinder reaches 32 atmosphere.

The Ministry of Saxony has recently expressed to the Canal Association in Leipzig the willingness of the Government to further the construction of a canal from Leipzig to the Saale, remarking: "This project has the important advantage, that the difference of level (21 m.) between the Elster and the Saale occurs mostly at one point, and can therefore be overcome by means of a vertical lift."

The Water Supply of Bombay, India.

The extensive works for the new water supply of the city of Bombay are now said to be approaching completion, although the contract time for completion is March, 1892. The work consists of the great Tansa Dam, with an aqueduct 53½ miles long. The greatest difficulties met with have been upon the construction of the latter, as it crosses mountains and valleys and unhealthy jungles, and work had to be prosecuted all along the line in order to complete it within the specified time. The following particulars are abstracted from an article in the Bombay *Gazette:*

Walsh, Lovett & Co., of Calcutta, secured the contract for the construction of the duct from Tansa Dam to Ghat Cooper, and commenced work in 1886. It comprises almost every description of engineering, excavation in earth and rock, masonry of various descriptions, aqueducts over ravines and valleys, tunnels, iron bridges and railways for carrying pipes and material. The contractors divided the work into eight sections, each with a superintending engineer and a complete staff of sub-agents, overseers, clerks, and timekeepers, and a chief engineer over the whole work. They at once set to work with an enormous staff, surveyed the country, put down the plant, and commenced operations within a very short period. Sickness caused serious delay. The fierce and blinding heat after the monsoon stewed the decaying vegetation into a fever-breathing mass, and the malarial poison struck down Europeans and natives alike; at one time the epidemic was so bad that 80 per cent. of these employed at Nevada, about 15 miles from Tansa, were sick with the fever. Cholera and influenza also became epidemic. Almost every member of the staff had to leave the place for lengthened periods to regain his health.

The water, in its passage from the lake, which is 400 ft. above Town Hall datum, and carried to Bom-

bay by gravity, passes through masonry conduits, metal-pipe siphons and tunnels. The masonry conduits are ducts of 25 miles in length, and are in most places 200 ft. to 300 ft. above the levels of the valleys. Owing to the precipitous character of the mountain sides, deep cutting in the hard rock was necessary. This has been done by hand drilling, and then blasting by gunpowder or dynamite. The masonry-arched channel, built into the cutting, is 11 ft. wide and 9 ft. high, with interior dimensions of 7 ft. by 7 ft. 3 in. They are built of greystone quarried out of the neighboring hills. They are all cement-pointed, and the floors are first covered with concrete and then cemented over, to prevent leakage. With water there is even greater trouble than with stone, as the quantity required for building is never found on the mountains, where it is most required, and frequently it has to be brought a distance of 1½ miles. Mortar cannot be mixed near the masonry work on the mountains and has to be done on the first level bit of land available on the plain below. There are 13 tunnels, from 200 to 8,000 ft. long, 9 × 6 ft. section, and aggregating 4 miles in length. Four of the longest have been driven by machinery. All kinds of boilers were used, with horizontal steam engines and air compressors for the drills, and steam pumps of various types for keeping the tunnels free from water, which rises very fast during the monsoons. The drilling of these tunnels was more difficult than railway tunnels, on account of the small space for working in and carrying out the débris. In the longest tunnels the driving was going on 3,000 ft. from the shaft, and in parts of the tunnel the water was up to the shoulders of the men. They are chiefly through hard rock, but where it is soft they have to be lined throughout with masonry, which in many cases has been dangerous work through slips.

An important feature of the work is the construction of the siphons, which are long lines of cast-iron pipes, 4 ft. diameter and 12 ft. long, for the purpose of getting the water over the valleys and low-lying ground. The conduit is built along the mountain side until it reaches the slope on the opposite side. At this point a large masonry chamber is constructed, where the water will accumulate. The end of the pipe is built into the side of the chamber, and the water can be run into it at will. The pipe line crosses the valley, in one case for a distance of nearly 11 miles. The grade at this siphon head is 50 per cent., and the pipes have to be kept from slipping and buckling by heavy check blocks of masonry. Each pipe is jointed and caulked with lead. The quantity of cast-iron pipes to be carried out and jointed up amounted to over 50,000 tons They were brought into Bombay in specially chartered steamers, and then sent up in boats by the Thana Creek to Kasheli. Here a depot was made and the pipes tested. The contractors had to construct a railway of 2 ft. 6 ins. gage through the valleys, with many steep grades and sharp curves, a distance of some 20 miles. The lifting of these pipes up the mountain sides required a large quantity of lifting tackle and skilled labor, as in places they are almost perpendicular, and rise to the height of 200 ft. to 300 ft. The duct has been constructed to deliver 34,000,000 galls. of water per day, but for the present the Municipality consider that they will have enough and to spare with half that quantity

There are three bridges, constructed of wrought-iron lattice girders, resting on cast-iron cylinders, over Bassein Creek. These are for carrying two pipes across, with a tramway in the center. The lengths vary from 400 ft. to 1,500 ft., in spans of 100 ft. The cast-iron cylinders are 5 ft. diameter, and were sunk through the beds of the creeks down to the rock, some of the cylinders being 100 ft. long. Divers were employed in removing the hard débris from the inside of the cylinders as they were sunk. The work was one of considerable difficulty, as the cylinders had to be fixed at this depth with a 14-ft. tide running 7 miles an hour. The divers were frequently engaged upon work 70 ft. below the surface of the water. There are 22 aqueducts aggregating 67 spans of 10 ft., 25 aggregating 80 spans of 20 ft., and two aggregating 13 spans of 30 ft. In addition to this work there are 100 culverts along the siphon track to provide for the drainage of the country.

The plans of the scheme were prepared by Mr. W. CLERKE. The contract for the dam was let to Glover & Co., of Bombay, and Mr. T. BERNARD HALL was the Chief Engineer, and had the entire direction and control of the work in India. The maximum number of natives employed on the work at one time was 20,000, and the cost, exclusive of land, filter-beds and distribution pipes, will exceed $5,000,000. The area of lake formed by the erection of the dam is 8 sq. miles; height of dam above base, 135 ft.; length between the mountains, 8,430 ft.; thickness at base, 96½ ft.; solid masonry in dam, 10,500,000 cu. ft. The duct has a length of 53½ miles; tunneling through hard trap rock, 4 miles; masonry conduit, 24½ miles; 48-in. cast-iron pipes in siphons, 25 miles; excavation in conduit trenches, 25,000,000 cu. ft.; earthwork embankments, 8,000,000 cu. ft.; masonry in conduits, 6,000,000 cu. ft. The duct has a capacity of 34,000,000 galls. per day, but at present half that quantity will suffice for the needs of the city. The work is the largest of its kind in India, and one of the largest in the world. It is being carried out at the expense of the city upon 5% bonds, repayable in 4 years.

Tables for Finding Stresses in Parallel-Chord Bridges, Uniformly Loaded, Having Verticals and Equal Panels.*

BY PROF. H. A. HITCHCOCK,
Thayer School of Civil Engineering.

The following article is not intended as a defense of the methods therein described. No claim is made that the stresses in a bridge should, or may, properly be determined by assuming a uniformly distributed load with or without excess loads. But if any one desires to analyze a truss thus loaded, it is believed that he will find the following tables convenient and labor saving.

Notation.

N = number of panels in supported chord; l = length of truss; h = height of truss; α = angle between vertical and diagonal; n = number of panel from left end; m = number of completely loaded panels; p = dead load per foot; s = number of panels between excess loads, w = live load per foot; P = excess load; p, w and P are for one truss.

Explanation.

(1) $\frac{p\,l}{2}$ = ½ dead load on bridge.

(2) $\frac{w\,l}{2}$ = ½ live load on bridge.

(3) $\frac{1}{8}\frac{w+p}{h}\,l^2$ = max. chord stress if N is even; if N is odd it is greater than any existing chord stress.

Dead load shear, used for verticals:

In the nth panel the shear will be given by

$$(4) \qquad S_1 = \frac{N-2n+1}{N}\left(\frac{p\,l}{2}\right)$$

These *percentages* of $\frac{p\,l}{2}$ are given in Table I.

Live load shears (approximate) used for verticals:

Assuming the maximum to obtain when panel concentrations are taken as those due to the uniformly distributed load extending to the middle of a panel, the whole of the load on the partially loaded panel being placed on the panel-point next to the loaded portion. (This assumption is almost universally made, and the results thus obtained are, except in end panels, larger than the true shears.)

The approximate shears are given by

$$(5) \qquad S_2 = \frac{(N-n)(N-n+1)}{N^2}\left(\frac{w\,l}{2}\right)$$

These percentages of $\frac{w\,l}{2}$ are given in Table II.

The greatest excess of approximate over true shear always occurs at middle of truss.

Live Load Shear.—If we wish to obtain the true shear in any panel n we must consider the load as extending a distance $x = \left(\frac{N-n}{N-1}\right)\frac{l}{N}$ upon the panel (not to the middle). We must also put a part $w\left(\frac{N-n}{N-1}\right)^2\frac{l}{2N}$, on the panel point to the left.

The true shears are given by

$$(6) \qquad S_3 = \frac{m^2}{N(N-1)}\left(\frac{w\,l}{2}\right).$$

These percentages of $\frac{w\,l}{2}$ are given in Table III.

Maximum Chord Stresses.—The maximum chord stresses will occur when the load covers the whole bridge. The chord stresses are given by

$$(7) \qquad C = 100\left(1-\left(\frac{N-2n}{N}\right)^2\right)\frac{w+p}{8h}\,l^2.$$

These percentages of $\frac{w+p}{8h}\,l^2$ are given in Table IV.

Preliminary Computations.—Find the constants:

$\frac{p\,l}{2}$, $\frac{p\,l}{2}\sec\alpha$, $\frac{w\,l}{2}$, $\frac{w\,l}{2}\sec\alpha$, $\frac{1}{8}(w+p)\frac{l^2}{h}$, $\frac{P\,l}{h}$.

Stress in Diagonals due to *Dead Load.*—Multiply $\frac{p\,l}{2}\sec\alpha$ by the percentages found in column N in Table I.

Stress in diagonals due to *live load.*—For *approx stresses* multiply $\frac{w\,l}{2}\sec\alpha$ by the percentages found in column N in Table II. For *true stresses* multiply $\frac{w\,l}{2}\sec\alpha$ by the percentages found in column N in Table III.

Maximum chord stresses due to a single *excess load P.*—Max. chord stress in the n_{th} panel due to one excess load P occurs when the excess load is placed at the centre of moments of that chord member.

These chord stresses are given by

$$(8) \qquad C_1 = \frac{n(N-n)}{N^2}\left(\frac{Pl}{h}\right)$$

These percentages of $\frac{Pl}{h}$ are given in Table V.

If there are two equal excess loads, each = P, the maximum chord stresses for different values of s are given in Tables VII., VIII., IX. and X., for s = 1, 2, 3 and 4 respectively.

Max. shear due to *one excess load load P.* Max. shear occurs in the n_{th} panel when the load is at the right end of the panel.

It is given by

$$(12) \qquad S_4 = \frac{N-n}{N}(P)$$

With another equal excess load P, s, panels to the right, the total max. shear in the n_{th} panel is given by

$$(13) \qquad S_5 = \frac{2N-(2+n+s)}{N}(P)$$

These percentages are found in Tables XI. XII. XIII. and XIV. for S=1, 2, 3, 4, respectively.

Use of Slide Rule.—The multiplying of $\frac{w\,l}{2}$, and the other constants, by the percentages found in the tables, may be much expedited by using a slide rule.

Rule.—Opposite 10 on A, set the constant on B; and opposite the proper percentage on A read off the answer on B.

Special Diagram.—We may make a special "scale A" to fit some given "scale B," having only such graduations on it as are needed. Fourteen such scales would be required for each value of N. All the necessary scales for values of N from 4 to 16 may be combined on a cardboard 7 × 10 ins. in size.

In an article in ENGINEERING NEWS for March 1, 1890, by Prof. FLETCHER, the live load shear (approximate) was found mechanically by projecting the required ordinate of the shear parabola upon an inclined scale of equal parts whose ends were placed on horizontals through the ends of the maximum ordinate of the shear parabola $\left(=\frac{w\,l}{2}\right)$ and whose intercept by such horizontals represented, to scale, $\frac{w\,l}{2}$. This parabola is recognized as an approximation, as it was drawn from end to end of truss, instead of from middle to middle of end panels. A true parabola would have been required for each value of N. These results are still larger than those given by (5).

No attempt has been made to deduce or explain any of the formulas used; those familiar with the

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subject will recognize them at once, and others should be well grounded in the principles before attempting to use any "short cut" like the one here given.

Octave Chanute.

PRESIDENT AMERICAN SOCIETY OF CIVIL ENGINEERS.

(WITH PORTRAIT.)

OCTAVE CHANUTE, the present President of the American Society of Civil Engineers, was born in Paris, France, Feb. 18, 1832; and came to the United States in the latter part of 1838. He received his education chiefly in New York City, and began the practice of his profession as a civil engineer in 1849, on the construction of the Hudson River Railroad, under JOHN B. JERVIS, Chief Engineer.

He was gradually promoted as the work progressed over the several divisions of the road, and when he left the service of that company, in 1853, he was Division Engineer at Albany, in charge of the completion of terminal facilities and maintenance of way between Hudson and Albany.

In 1853 he went to Illinois with H. A. GARDNER, previously Chief Engineer of the Hudson River R. R., and was there engaged in building what is now a part of the Chicago & Alton R. R., between Joliet and Bloomington, in Illinois. Mr. CHANUTE remained upon this work until 1854, when he was made Chief Engineer of the Eastern portion of what is now the Toledo, Peoria & Warsaw R. R. He built this road from Peoria to the Indiana State line, a distance of about 112 miles, and remained in charge of maintenance of way until 1861. In the latter year he became Division Engineer, with similar duties on the Pittsburg, Fort Wayne & Chicago R. R., between Chicago and Fort Wayne.

In 1862 he was for six months Chief Engineer of Maintenance of Way of the Western Division of the Ohio & Mississippi R. R., from St. Louis to Vincennes. In 1863 he became Chief Engineer of Maintenance of Way and Construction of the reorganized Chicago & Alton R. R., and remained upon that line until 1867.

During this connection, having been invited to submit a design for the proposed Union Stock Yards of Chicago, his plan was selected in competition with a number of others and he built these yards as Chief Engineer. He was also awarded a premium for a competitive design for a bridge across the Missouri River at St. Charles, Missouri. In 1867 Mr. CHANUTE went to Kansas City, Mo., as Chief Engineer of the bridge across the Missouri River at that point. This was the pioneer bridge across the Missouri River, and as the river pilots and riparian dwellers had given this stream a bad reputation, the successful completion of this bridge across it in 1868 attracted great attention and interest.

Meanwhile the building of railroads had begun in Kansas, and while yet occupied in the completion of the bridge, Mr. CHANUTE was placed in charge as Chief Engineer first of the construction of the Kansas City, Fort Scott & Gulf R. R., from Kansas City to the north line of the Indian Territory, 160 miles; next of a parallel line in the same interest, then known as the Leavenworth, Lawrence & Galveston R. R., from Lawrence, Kan., to the Indian Territory; next of a connecting line between the two, known as the Kansas City & Santa Fé R. R., and lastly of the Atchison & Nebraska R. R., from Atchison northward.

While simultaneously in charge of the construction of these four railroads, he also designed and built the Union Stock Yards at Kansas City; and in 1871, as the work drew to a close, he became General Superintendent of the Leavenworth, Lawrence & Galveston R. R.

In 1873 he was offered and accepted the position of Chief Engineer of the Erie Ry., which, having changed its management, was planning to make extensive improvements. These were to consist of doubling the tracks and narrowing the gage; building an extension to Chicago and another to Boston, involving the Poughkeepsie Bridge since built in another interest; building sundry branches, and improving the property generally at an estimated outlay of some fifty millions of dollars, which it was expected to obtain in England.

The panic of 1873 and the subsequent financial depression prevented the full carrying out of this programme. Mr. CHANUTE, however, remained upon the Erie Ry. 10 years, during which time much of the line was double-tracked upon improved grades, the gage reduced to the standard by laying down a third rail, and the facilities of the line largely improved. In 1875 he was made Assistant General Superintendent, and in 1876 was placed temporarily in charge of the motive power and rolling stock, in addition to his duties as Chief Engineer. This gave him an opportunity of readjusting the locomotives as well as the grades, so that the through freight train which averaged 18 cars when he first became connected with the line, had grown to 35 cars when he closed his connection with the road in 1883, when he removed from New York to Kansas City, in order to look after his personal interests, and to open an office as Consulting Engineer.

In this latter capacity he took charge of the construction of the iron bridges during the building of the Chicago, Burlington & Northern R. R. between Chicago and St. Paul in 1885, and of those of the extension of the Atchison, Topeka & Santa Fé R. R., from Kansas City to Chicago in 1887 and 1888; the latter involving, besides a number of minor streams, the Missouri River bridge at Sibley, and the Mississippi River bridge at Ft. Madison.

In 1889 Mr. CHANUTE removed his office to Chicago, where he is now principally engaged in promoting the preservation of timber against decay by chemical methods; he being of the opinion that the time has now fully arrived when large economies are to be attained in this country by employing the methods which are in current use abroad.

Mr. CHANUTE became a member of the American Society of Civil Engineers Feb. 19, 1868, and has contributed a goodly number of papers to its Transactions. Among these may be mentioned, "The Elements of Cost of Railroad Freight Traffic," "Rapid Transit and Terminal Freight Facilities," "The Preservation of Timber," the latter two being reports by committees of which he was chairman; "Engineering Progress in the United States," "Repairs of Masonry," and "Uniformity in Railroad Rolling Stock," besides some contributions to various other societies.

He was Vice-President in 1880-81, and became President of the society at the last election.

THE SOO CANAL SCARE is greatly exaggerated, says General POE. The reports now circulated by certain Lake Superior vessel owners and agents are generally absurd, especially as to the liability of a break stopping traffic "for three years." General POE says three months' work would put the most serious break possible into order again. But the canal does need prompt attention.

THE BOARD OF TRADE OF JOHNSTOWN, PA., has employed Messrs. J. J. R. CROES and HUNT, of New York, to report upon the best means of avoiding damage by future floods at that place. The surveys have been made, and plans are being prepared at a cost of about $6,000, says "a special" from that town. The sum of $2,700 had previously been expended on another survey.

A NEW CAST-STEEL GUN PROCESS has been patented by JAMES A. MCINERNEY and HENRY HANKS, of Pittsburg, Pa. The process consists in having a core of crucible cast steel of the finest quality, covered with a jacket or banded with a homogeneous soft steel welded to the core. The core will be cast hollow, with a small aperture to facilitate the entrance of the boring and rifling tools. The steel to be used is highly carbonized crucible steel. The soft steel cover is of the lowest grade of steel or a high-grade iron, very tenacious, capable of resisting a very great disruptive force. The two qualities of metal will be welded and hammered, making a thoroughly solid shell, and combining the two desirable qualities of toughness on the outside and extreme hardness in the interior.

AN ARTESIAN WELL 775½ ft. deep, with a 6-in. strainer 41 ft. long, was recently sunk for the Southern Ice Co., corner Fourth and Water Sts., New Orleans, in 11 hours and 20 minutes. The contractors were Elder Brothers, 37 Natchez St. Mr. B. W. ELDER informs us that the wells are sunk on the hydraulic jet principle with special tools patented by the firm. Part of the material pierced in the above well is described as tough, dry, waxy-blue clay, but most of it was quicksand, shells, and gravel. Mr. ELDER says that the latter materials are the well borer's "stumbling-block," especially when the jetting process is used, owing to the fact that the water is so rapidly absorbed by the material pierced that but little remains to be forced up on the outside of the pipe. Mr. ELDER states that the only rock encountered in the vicinity of New Orleans is a 6-in. stratum of sandstone at a depth of from 685 to 710 ft. The New Orleans *Picayune* states that the well in question has a natural flow of 200 galls. per minute, which it is expected to increase to 800 galls. by the aid of a vertical pump. The water is said to have a temperature of about 74°.

RAILWAY SCHOOLS for the children of employees are maintained by the railway companies of India, a location being generally chosen in the hill districts,

ELEMENTS OF WEATHER IN THE UNITED STATES, OF MOST INTEREST TO ENGINEERS, FOR THE MONTH OF APRIL, 1891.
[Furnished to ENGINEERING NEWS by the Chief Signal Officer, U. S. A.]

	STATION.	Temperature. (Deg. Fah.) Average.	Max.	Min.	Range.	Wind. Velocity in miles per hour. Average.	Maxim.	Direction at time of max. velocity.	Precipitation.—Rain and melted snow. Inches. Total.	Heaviest in 24 hours.	Number of rainy days.
NORTHERN CITIES.	Northfield, Vt.	41.3	78	10	68	10.0	36	W	2.41	0.94	10
	Portland, Me.	43.6	76	26	50	8.2	40	NE	1.89	0.59	10
	New York City	52.0	80	28	52	12.2	37	NW	2.37	1.07	10
	Pittsburg, Pa.	53.4	81	24	57	5.5	30	SW	1.18	0.49	11
	Chicago, Ill.	47.0	75	23	52	16.7	50	SE	3.14	1.48	15
	Omaha, Neb.	54.1	90	17	73	9.3	32	NW	2.80	0.97	10
	St. Paul, Minn.	48.2	83	13	70	8.4	33	NW	1.71	0.64	9
	Duluth, Minn.	39.3	81	11	70	7.1	35	NW	1.71	0.61	9
	Bismarck, N. Dak.	47.2	90	8	82	12.8	48	NW	2.40	0.94	8
	Average	47.3	81.6	17.8	63.8	10.0	38	.....	2.18	0.86	10
SOUTHERN CITIES.	Washington City	65.0	85	29	56	7.0	28	NW	2.94	1.77	8
	Louisville, Ky.	59.6	88	28	60	6.6	36	SW	2.42	0.69	12
	St. Louis, Mo.	58.7	82	27	55	12.5	40	SW	2.29	0.54	10
	Savannah, Ga.	65.2	83	34	49	7.3	24	NW	2.91	1.70	6
	Leavenworth, Kan.	57.0	84	25	59	7.3	36	SW	3.95	1.40	10
	Jacksonville, Fla.	67.4	86	34	52	7.1	30	W	1.72	0.64	6
	Chattanooga, Tenn.	62.2	89	32	57	5.9	30	NW	2.42	0.86	12
	New Orleans, La.	68.0	84	41	43	9.2	26	NW	0.26	0.18	2
	Memphis, Tenn.	64.2	86	33	54	6.8	35	W	2.72	1.20	7
	Palestine, Tex.	65.8	87	36	51	6.8	36	S	8.95	3.33	13
	Average	63.3	85.4	31 9	53 5	7.6	32	.....	3.06	1.23	9
WESTERN CITIES	Helena, Mont.	47.4	82	19	63	7.3	42	SW	0.76	0.66	3
	San Francisco, Cal.	53.4	81	40	41	8.8	28	SW	2.44	1.20	9
	Salt Lake City, Utah	49.6	79	24	55	5.2	36	S	1.49	0.44	8
	Denver, Col.	48.0	82	6	76	7.8	38	SW	2.49	0.88	6
	Yuma, Ariz.	67.7	102	44	58	7.1	36	W	....	....	0
	Santa Fé, N. Mex.	46.4	74	18	56	8.8	32	NE	0.17	0.14	3
	Average	52.1	83.3	25.2	58.2	7.5	35	.....	1.22	0.55	5

Tables for Finding Stresses in Parallel-Chord Bridges, Uniformly Loaded, Having Verticals and Equal Panels.

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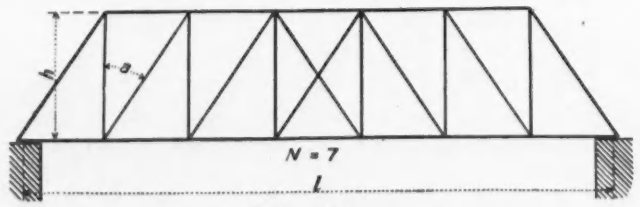
NOTATION.

N = number of panels in supported chord.
l = length of truss.
h = height of truss.
a = angle between vertical and diagonal.
n = number of panel from left end.
m = number of completely loaded panels.



Type of Bridge.

NOTATION.

p = dead load per foot.
P = excess load.
s = number of panels between excess loads.
w = live load per foot.
p, w and P are for one truss.

TABLE I.

DEAD LOAD SHEAR.—PERCENTAGES OF $\frac{pl}{2}$ AND $\frac{pl}{2}$ SEC. a.

Number of Panels in the Truss.

No. of panel from left end.	16.	15.	14.	13.	12.	11.	10.	9.	8.	7.	6.	5.	4.
1	93.750	93.333	92.859	92.304	91.667	90.909	90.000	77.778	87.500	85.719	83.333	80.000	75.000
2	81.250	80.000	78.570	76.920	75.000	72.727	70.000	55.556	62.500	57 143	50.000	40.000	25.000
3	68.750	66.667	64.287	61.5-6	58.333	54.545	50.000	33.333	37.500	28.571	16.667	0	.....
4	56.250	53.333	50.000	46.152	41.667	36.364	30.000	11.111	12.500	0	.....	.....	.....
5	43.750	40.000	35.715	30.768	25.000	18.182	10.000	0	.....	.....	.....	.....	.....
6	31.250	26.667	21.429	15.384	8.333	0	.....	.....	.....	.....	.....	.....	.....
7	18.750	13.333	7.143	0	.....	.....	.....	.....	.....	.....	.....	.....	.....
8	6.250	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

TABLE II.

LIVE LOAD SHEAR (Approx.).—PERCENTAGES OF $\frac{wl}{2}$ AND $\frac{wl}{2}$ SEC. a.

Number of Panels in the Truss.

Number of panel from left end.	16.	15.	14.	13.	12.	11.	10.	9.	8.	7.	6.	5.	4.
1	93.750	93.333	92.857	92.308	91.667	90.909	90.000	88.889	87.500	85.714	83.333	80.000	75.000
2	82.031	80.889	79.592	78.106	76.388	74.380	72.000	69.136	65.625	61.224	55.556	48.000	37.500
3	71 094	69.333	67.347	65.089	62.500	59.504	56.000	51.852	46.875	40.816	33.333	24.000	12.500
4	60.938	58.667	56.302	53.254	50.000	46.281	42.000	37.037	31 250	24.490	16.667	8.000	0
5	51.562	48.889	45.918	42.603	38.889	34.711	30 000	24 691	18.750	12.244	5.556	0	.....
6	42.968	40.000	36.735	33.136	29.167	24.793	20.000	14.813	9.375	4.081	0	.....	.....
7	35.157	32.000	28.571	24.852	20.833	16.529	12 000	7.407	3.125	0	.....	.....	.....
8	28.125	24.889	21.429	17.752	13.889	9.917	6.000	2.469	0	.....	.....	.....	.....
9	21.875	18.667	15.307	11.834	8.333	4.958	2 000	0	.....	.....	.....	.....	.....
10	16.406	13.333	10.204	7.101	4.167	1 652	0	.....	.....	.....	.....	.....	.....
11	11.719	8.889	6.122	3.550	1.389	0	.....	.....	.....	.....	.....	.....	.....
12	7.813	5.333	3.031	1.183	0	.....	.....	.....	.....	.....	.....	.....	.....
13	4.687	2.667	1.020	0	.....	.....	.....	.....	.....	.....	.....	.....	.....
14	2.344	0.889	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
15	0.781	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
16	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

TABLE III.

TABLE VII.

MAX. CHORD STRESSES, WITH 2 EXCESS LOADS, $s = 1$.—PERCENTAGES OF $\frac{Pl}{h}$.

Number of Panels in the Truss.

No. of panel from left end.	16.	15.	14.	13.	12.	11.	10.	9.	8.	7.	6.	5.	4.
1	11.327	12.000	12.755	13.610	14.584	15.628	17.000	18.518	20.312	22.449	25.000	28.000	31.250
2	21.093	22.222	23.469	24.792	26.389	28.099	30.000	32.097	34.375	36.735	38.889	40.000	37.500
3	29.297	30.667	32.143	33 638	35.417	36.591	39.000	40.778	42.187	42.858	41.667	.....	.....
4	35.937	37.333	38.775	40.236	41.667	42.957	44.000	44.534	45.000	.....	.....	.....	.....
5	41.015	42.222	43.321	44.377	45.556	45.454	45.000	.....	.....	.....	.....	.....	.....
6	44.530	45.333	45.862	46.152	45.833	.....	.....	.....	.....	.....	.....	.....	.....
7	46.484	45.778	46.380	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
8	46 875	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

TABLE VIII.

MAX. CHORD STRESSES, WITH 2 EXCESS LOADS, $s = 2$.—PERCENTAGES OF $\frac{Pl}{h}$.

Number of Panels in the Truss.

No. of panel from left end.	16.	15.	14.	13.	12.	11.	10.	9.	8.	7.	6.	5.	4.
1	10.937	11.556	12.245	12.988	13.889	14 802	16.000	17.284	18.749	20 408	22.222	24.000	25.000
2	20 312	21.333	22 448	23.669	25.000	26.447	28.000	29.653	31.250	32.653	33.333	32.000	25.000
3	28.124	29.333	30.612	31.862	33.333	34 711	36.000	37.067	37.500	36.735	33.333	.....	.....
4	34.375	35.556	36.975	37.890	38.889	39.670	40.000	39.556	37.500	.....	.....	.....	.....
5	39.062	40.000	40.816	41.419	41.667	41.322	40.000	.....	.....	.....	.....	.....	.....
6	42.187	42.667	42.760	42.602	41.667	.....	.....	.....	.....	.....	.....	.....	.....
7	43 749	43.556	42.857	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
8	43.757	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

TABLE IX.

MAX. CHORD STRESSES, WITH 2 EXCESS LOADS, $s = 3$.—PERCENTAGES OF $\frac{Pl}{h}$.

Number of Panels in the Truss.

No. of panel from left end.	16.	15.	14.	13.	12.	11.	10.	9.	8.	7.	6.	5.
1	10.547	11.111	11.735	12.427	13.195	13.975	15.000	16.061	17.187	18.368	19.444	22.000
2	19.531	20.444	21.428	22.485	23 611	24.793	26.000	27 178	28.125	28.571	27.778	24.000
3	26.953	28.000	29.054	30 087	31.250	32.232	33.000	33.333	32.812	30.613	27.778	.....
4	32.812	33.778	34.694	35.503	36.111	36.364	36.000	34.616	31.250	.....	.....	.....
5	37.107	37.778	38.220	38.461	38.195	42.149	35.000	.....	.....	.....	.....	.....
6	39.843	40.000	39.740	39.052	37.500	.....	.....	.....	.....	.....	.....	.....
7	41.015	42.667	39.286	.....	.....	.....	.....	.....	.....	.....	.....	.....
8	40.625	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

TABLE X.

Number of panel from end													
8	28.125	24.889	21.429	17.792	13.889	9.677	5.000	0	.....	.....	.....	.....	.....
9	21.875	18.667	15.307	11.834	8.333	4.958	2.000	0	.....	.....	.....	.....	.....
10	16.406	13.333	10.204	7.101	4.167	1.652	0	.....	.....	.....	.....	.....	.....
11	11.719	8.889	6.122	3.550	1.389	0	.....	.....	.....	.....	.....	.....	.....
12	7.813	5.333	3.031	1.183	0	.....	.....	.....	.....	.....	.....	.....	.....
13	4.687	2.667	1.020	0	.....	.....	.....	.....	.....	.....	.....	.....	.....
14	2.344	0.889	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
15	0.781	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
16	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

TABLE III.

LIVE LOAD SHEAR.—PERCENTAGES OF $\frac{wl}{2}$ AND $\frac{wl}{2}$ SEC. a.

Number of Panels in the Truss.

Number of the panel from left end.	16.	15.	14.	13.	12.	11.	10.	9.	8.	7.	6.	5.	4.
1	93.750	93.333	92.857	92.308	91.667	90.909	90.000	88.889	87.500	85.714	83.333	80.000	75.000
2	81.667	80.476	79.121	77.564	75.758	73.636	71.111	68.050	64.286	59.524	53.333	45.000	33.333
3	70.417	68.571	66 484	64.103	61.364	58.182	54.444	50.000	44.643	38.095	30.000	20.000	8.333
4	60.000	57.619	54.945	51.923	48.485	44.545	40.000	34.722	28.571	21.428	13.333	5.000	0
5	50.417	47.619	44.505	41.026	37.121	32.727	27.778	22.222	16.071	9.524	3.333	0	.....
6	41.667	38.571	35.165	31.410	27.273	22.727	17.778	12.500	7.143	2.381	0	.....	.....
7	33.750	30.476	26.923	23.077	18.939	14.545	10.000	5.556	1.786	0	.....	.....	.....
8	26.6 7	23.333	19.780	16.026	12.121	8.182	4.444	1.389	0	.....	.....	.....	.....
9	20.417	17.143	13.736	10.256	6 818	3.636	1.111	0	.....	.....	.....	.....	.....
10	15.000	11.905	8.791	5.769	3.030	0.909	0	.....	.....	.....	.....	.....	.....
11	10.417	7.619	4.945	2.564	0.758	0	.....	.....	.....	.....	.....	.....	.....
12	6.667	4.290	2.198	0.641	0	.....	.....	.....	.....	.....	.....	.....	.....
13	3.750	1.904	0.550	0	.....	.....	.....	.....	.....	.....	.....	.....	.....
14	1.667	0.476	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
15	0.417	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
16	0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

TABLE IV.

MAX. CHORD STRESSES.—PERCENTAGES OF $\frac{1}{8}\ (w+p)\frac{l^2}{h}$.

Number of Panels in the Truss.

No. of panel from left end.	16.	15.	14.	13.	12.	11.	10.	9.	8.	7.	6.	5.	4.
1	25.434	24.889	26.531	28.402	30.556	33.058	36.000	39.506	43.750	48.980	55.556	64.000	75.000
2	43.750	45.222	48.979	52.071	55.556	59.504	64.000	69.136	75.000	81.633	88.889	96 000	100
3	60.937	64.000	67.348	71.006	75.000	79.239	84.000	88.889	93.750	97.959	100	.....	.....
4	75.000	78.222	81.643	85.207	88.889	92.562	96 000	98.765	100	.....	.....	.....	.....
5	85.937	88.889	91.837	94.675	97.222	99.173	100	.....	.....	.....	.....	.....	.....
6	93.750	96.000	97.959	99.408	100	.....	.....	.....	.....	.....	.....	.....	.....
7	98.437	99.556	100	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
8	100	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

TABLE V.

MAX. CHORD STRESSES, 1 EXCESS LOAD.—PERCENTAGES OF $\frac{P\,l}{h}$.

Number of Panels in the Truss.

No. of the panel from left end.	16.	15.	14.	13.	12.	11.	10.	9.	8.	7.	6.	5.	4.
1	5.859	6.222	6.633	7.101	7.639	8.190	9.000	9.877	10.937	12.245	13.889	16.000	18.750
2	10.937	11.556	12.244	13.018	13.889	14.876	16.000	17.282	18.750	20.408	22.222	24.000	25
3	15.234	16.000	16.837	17.661	18.750	19.835	21.000	22.222	23.437	24.490	25	.....	.....
4	18.750	19.556	20.408	21.302	22.222	23.141	24.000	24.741	25	.....	.....	.....	.....
5	21.484	22.222	22.959	23.668	24.305	24.793	25	.....	.....	.....	.....	.....	.....
6	23.437	24.000	24.434	24.851	25	.....	.....	.....	.....	.....	.....	.....	.....
7	24.609	24.889	25	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
8	25	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

TABLE VI

MAX. SHEAR, 1 EXCESS LOAD.—PERCENTAGES of P.

Number of Panels in the Truss.

Number of the panel from left end.	16.	15.	14.	13.	12.	11.	10.	9.	8.	7.	6.	5.	4.
1	93.750	93.333	92.857	92.308	91.667	90.909	90.000	88.889	87.500	85.714	83.333	80.000	75 000
2	87.500	86.667	85.714	84.615	83.333	81.727	80.000	77.778	75.000	71.428	66.667	60.000	50
3	81 250	80 000	78.571	76.923	75.00	72.727	70.000	66.667	62.500	57.145	50	.....	.....
4	75.000	73.333	71.428	69.230	66.667	63.636	60.000	55.556	50	.....	.....	.....	.....
5	68.750	66.667	64.286	61.538	58 333	54.545	50	.....	.....	.....	.....	.....	.....
6	62.50)	60.000	57.143	53.846	50	.....	.....	.....	.....	.....	.....	.....	.....
7	56.250	53.333	50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
8	50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

No. of panel from left end.	16.	15.	14.	13.	12.	11.	10.	9.	8.	7.	6.	5.	
1	10.547	11.111	11.735	12.427	13.195	13.975	15.000	16.061	17.187	18.368	19.444	22.000	.....
2	19.531	20.444	21.428	22.485	23 611	24.793	26.000	27 178	28.125	28.571	27.778	24.000	.....
3	26.953	28.000	29.054	30 087	31.250	32.232	33.000	33.333	32.812	30.613	27.778	.....	.....
4	32.812	33.778	34.694	35.503	36.111	36.364	36.000	34.616	31.250	.....	.....	.....	.....
5	37.107	37.778	38.220	38.461	38.195	42.149	35.000	.....	.....	.....	.....	.....	.....
6	39.843	40.000	39.740	39.052	37.500	.....	.....	.....	.....	.....	.....	.....	.....
7	41.015	42.667	39.286	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
8	40.625	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

TABLE X.

MAX. CHORD STRESSES, WITH 2 EXCESS LOADS, $s = 4$.—PERCENTAGES OF $\frac{P\,l}{h}$.

Number of Panels in the Truss.

No. of panel from left end.	16.	15.	14.	13.	12.	11.	10.	9.	8.	7.	6.	5.	
1	10.156	10.667	11.225	11.835	12.500	13.149	14.000	14.825	15.624	16.327	16.667	.....	.....
2	18.749	19.556	20.389	21.302	22.222	23.140	24.000	24.689	25.000	24.490	22 222	.....	.....
3	25.781	26.667	27.551	28.311	29.166	29.753	30.000	29.629	28.124	24.490	25.000	.....	.....
4	31.250	32.000	32.624	33.136	33.333	33.059	32.000	29.680	25.000	.....	.....	.....	.....
5	35.156	35.556	35.714	35.503	34.722	33.885	30.000	.....	.....	.....	.....	.....	.....
6	37.499	37.333	36.679	35.448	33.333	.....	.....	.....	.....	.....	.....	.....	.....
7	38.281	37.333	35.714	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
8	37.500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

TABLE XI.

MAX. SHEAR, WITH 2 EXCESS LOADS, EACH = P; $s = 1$.—PERCENTAGES OF P.

Number of panels in the truss.

No. of panel from left end.	16.	15.	14.	13.	12.	11.	10.	9.	8.	7.	6.	5.	4.
1	181.250	180.000	178.572	176.923	175.000	172.727	170.000	166.667	162.500	157 143	150 000	140.000	125.000
2	168.750	166.667	164.286	161.539	158.333	154.545	150.000	144.444	137.500	128.571	116.667	100.	75.000
3	156.250	153.333	150.000	146.154	141 667	136.364	130.000	122.222	112.500	100.	83 333	.....	.....
4	143.750	140.000	135.714	130.769	125.000	118.182	110.000	100.	87.500	.....	.....	.....	.....
5	131.250	126 667	121.429	115.385	108.333	100.	90.000	.....	.....	.....	.....	.....	.....
6	118.750	113.333	107.143	100.	91.667	.....	.....	.....	.....	.....	.....	.....	.....
7	106.250	100.	92.857	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
8	93.750	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

TABLE XII.

MAX. SHEAR, WITH 2 EXCESS LOADS, EACH = P; $s = 2$.—PERCENTAGES OF P.

Number of Panels in the Truss.

No. of panel from left end.	16.	15.	14.	13.	12.	11.	10.	9.	8.	7.	6.	5.	4.
1	175.000	173.333	171.429	169.231	166.667	163.636	160.000	155.556	150.000	142.857	133.333	120.000	100.000
2	162.500	160.000	157.143	153.846	150.000	145.454	140.000	133.333	125.000	114.286	100.	80.000	50.000
3	150.000	146.667	142.857	138.462	133.333	127.273	120.000	111.111	100.	85.714	66.667	.....	.....
4	137.500	133.333	128.572	123.077	116.667	109.091	100.000	88.889	75.000	.....	.....	.....	.....
5	125.000	120.000	114.286	107.692	100.	90.909	80.000	.....	.....	.....	.....	.....	.....
6	112.500	106.667	100.	92.308	83.333	.....	.....	.....	.....	.....	.....	.....	.....
7	100.	93.333	85.714	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
8	87.500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

TABLE XIII.

MAX. SHEAR, WITH 2 EXCESS LOADS, EACH = P; $s = 3$.—PERCENTAGES OF P.

Number of Panels in the Truss.

No. of panel from left end.	16.	15.	14.	13.	12.	11.	10.	9.	8.	7.	6.	5.	4.
1	168.750	166.667	164.286	161.539	158.333	154.545	150.000	144.444	137.500	128.571	116.667	100	75.000
2	156.250	153.333	150.000	146.154	141.667	136.364	130.000	122.222	112.500	100.	83.333	60.000	50.000
3	143.750	140.000	135.714	130.769	125.000	118.182	110.000	100.	87.500	71.429	50.000	.....	.....
4	131.250	126.667	121.429	115.385	108.333	100.	90.000	77.778	62.500	.....	.....	.....	.....
5	118.750	113.333	107.143	100.	91.667	81.818	70.000	.....	.....	.....	.....	.....	.....
6	106.250	100.	92 857	84.615	75.000	.....	.....	.....	.....	.....	.....	.....	.....
7	93.750	86.667	78.572	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
8	81.250	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

TABLE XIV.

MAX. SHEAR, WITH 2 EXCESS LOADS, EACH = P; $s = 4$.—PERCENTAGES OF P.

Number of Panels in the Truss.

No. of panel from left end.	16.	15.	14.	13.	12.	11.	10.	9.	8.	7.	6.	5.	4.
1	162.500	160.000	157.143	153 846	150.000	145.454	140.000	133.333	125.000	114.286	100.	80.000	75.000
2	150.000	146.667	142.857	138.462	133.333	127.273	120.000	111.111	100.	85.714	66.667	60.000	50.000
3	137.500	133 333	128.572	123.077	116.667	109.091	100.	88.889	75.000	57.143	50.000	.....	.....
4	125.000	12 .000	114.286	107.692	100.	90.909	80.000	66.667	50.000	.....	.....	.....	.....
5	112.500	106.667	100.	92.308	83.333	72.727	60.000	.....	.....	.....	.....	.....	.....
6	100.	93.333	85.714	76.923	66.667	.....	.....	.....	.....	.....	.....	.....	.....
7	87.500	80.000	71.429	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
8	75.000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

No. of the panel from left end.	1	2	3	4	5	6	7	8
1	99.750	93.333	92.857	92.308	91.667	90.909	90.000	88.889
2	87.500	86.667	85.714	84.615	83.333	81.818	80.000	77.778
3	75.000	73.333	71.428	69.230	66.667	63.636	60.000	55.556
4	62.500	60.000	57.143	53.846	50	45.455	40.000	33.333
5	50.000	46.667	42.857	38.462	33.333	27.273	20.000	11.111
6	37.500	33.333	28.571	23.077	16.667	9.091	0.000	
7	25.000	20.000	14.286	7.692	0.000			
8	12.500	6.667	0.000					
9	0.000							

No. of panel from left end.	1	2	3	4	5	6	7	8
1	99.750	93.333	92.857	92.308	91.667	90.909	90.000	88.889
2	87.500	86.667	85.714	84.615	83.333	81.818	80.000	77.778
3	75.000	73.333	71.428	69.230	66.667	63.636	60.000	55.556
4	62.500	60.000	57.143	53.846	50	45.455	40.000	33.333
5	50.000	46.667	42.857	38.462	33.333	27.273	20.000	11.111
6	37.500	33.333	28.571	23.077	16.667	9.091	0.000	
7	25.000	20.000	14.286	7.692	0.000			
8	12.500	6.667	0.000					
9	0.000							

where the cooler climate and purer air will conduce to the health of the pupils. The fees charged for board and tuition are generally barely sufficient to cover the cost of plain food, and the deficit is made up by the companies.

THE LONDON TOWER CO., which proposes to build a tower about 1,200 ft. high, or 200 ft. taller than the Eiffel Tower, has purchased a site at Wembley, on the Metropolitan Railway, for $165,000. The site is 140 ft. higher than the Eiffel, and it is proposed to build the tower of steel instead of iron. The foundation soil is well adapted to the purpose proposed, and the cost of the foundations, as estimated by the engineer, Sir BENJAMIN BAKER, is only $25,000. The estimated cost of the tower, including elevators, is $1,500,000.

ANOTHER SIAMESE RAILWAY CONCESSION has been granted by the King, dated March 5. The railway would cross the Malay peninsula, from Singora to Kota Star, and thence to Kulem, a tin mining district in the southern part of the Province of Kedah. The concession is granted to Mr. CHARLES DUNLOP, of Singapore.

THE CAPE COD SHIP CANAL enterprise is very well described in a recent issue of the *Polytechnic*. The proposed canal would cross Cape Cod along a low ravine near the mainland, and would be 7 or 8 miles in length. The deepest cut from the surface of the ground to the bottom of the canal would be 56 ft.

All the work so far done has been on the marshes at the north end, where a channel has been dug to a depth of 9 ft. and width of 175 ft. for a distance of about 1½ miles. Since the work began the constantly changing sandbars and the sand that is always blowing from the row of hills between the shore and the marsh have nearly closed the entrance. The work thus far accomplished has been done by a floating dredge working an endless chain of excavating buckets and depositing the material on shore by a pipe carrier. The dredge has a capacity of about 450 cu. yds. per day. No work has been done on the canal for nearly a year. About $1,300,000 has already been spent. The total estimated cost was about $5,000,000. Some further details may be found in our issue of Aug. 10, 1889.

THE EXPERIMENTAL FLYING MACHINE OF MR. HIRAM J. MAXIM, built at his works near Kent, England, promises good results. Mr. MAXIM, in a late interview, describes this machine as an inclined plane, 13 ft. by 4 ft. This plane is balanced on a revolving arm 30 ft. long and so arranged that it can rise and fall. It is propelled by a wooden screw revolving at the rate of 1,000 to 2,500 revolutions per minute. When the machine travels at the rate of 30 miles per hour it remains on the same plane; at 35 miles it begins to rise, and at 90 miles it broke the guy wire and showed great lifting power. Mr. MAXIM says he has already expended $45,000 on these tests and is now at work on a large machine of silk and steel, with a plane 110 ft. by 40 ft. with two wooden screws 18 ft. in diameter. A petroleum condensing engine will furnish the power. In his previous experiments he found that one horse-power would carry 133 lbs. 75 miles per hour. It was also proven that the screw would lift forty times as much on the propelled plane as it could push. A motor has been built, weighing 1,800 lbs., which pushes 1,000 lbs., and will consequently lift 40,000 lbs. The estimated weight of his engines, generator, condenser, water supply (2 galls.), petroleum (40 lbs. per hour), and two men, is about 5,000 lbs. Mr. MAXIM is in earnest and is very confident of ultimate success.

A DYNAMITE EXPLOSION, May 19, on a construction train of the New York Central & Hudson River R. R., killed 15 workmen and injured several others. The dynamite was on a flat car, which was being drawn by a locomotive, and the Italian laborers who were killed were riding on the car. There is some controversy as to the cause of the explosion; but it is stated that the carrying of the dynamite on the car was contrary to orders.

THE PRODUCTION OF MANGANESE ORES in the United States has increased from 5,761 tons in 1880 to 23,927 tons in 1889, according to Census Bulletin No. 68, by far the larger proportion of the ore is obtained from Crimora, Va., Cartersville, Ga., and Batesville, Ark. The mines at the first place are the most important, producing 14,616 tons in 1889, or 61% of the total production. The average value of the ore is at present $10 per ton.

THE NIAGARA FALLS TUNNEL COMPANY, at a late meeting of directors and engineers, report that the first section of the main canal will be started in about 30 days. The canal will be 180 ft. wide at its mouth, 1,200 ft. long, and will narrow down gradually to 100 ft. wide. The hydraulic plant of the Cataract Construction Co. will be located on the east side of the mouth of this canal. A large paper making plant is to be put on the west side. At shaft No. 1 the bottom is reached and a begining made in driving the tunnel. At shaft No. 2 the heading is driven about 60 ft. each way. At this meeting Engineers CLEMENS HERSCHEL, JOHN BOGART and ALBERT H. PORTER had a consultation with Col. THEO. TURETTINI of Geneva, who is the foreign consulting engineer for hydraulic and electrical plant.

FLORICULTURE is the subject of a recent census bulletin, and this is the first time that a census investigation has been made. While it has been carried on as a business for over 100 years, it is only within the past 25 years that it has assumed large proportions. Out of a total of 4,659 establishments, 2,795 were started between 1870 and 1890, and 1,757 of these between 1880 and 1890. In the census year these 4,659 establishments had 38,823,247 sq. ft. of glass, covering over 891 acres of land. They were valued at $38,355,722, including fixtures and heating apparatus; tools and implements, $1,587,633. They gave employment to 16,847 men and 1,958 women, who earned $8,483,657 in the year. Women own and manage 312 of the establishments. Fuel for heating cost $1,160,152. The products for the year reached a value of $12,037,477, and cut flowers brought an additional income of $14,175,328. There are issued annually 3,425,000 wholesale and 17,630,094 retail catalogues. In addition to the Society of American Florists there are 956 state and local floral societies and clubs and 358 horticultural societies.

AMERICAN WATER-METER COMPANIES are having great success in bringing positive measuring water meters into general use, as our advertising columns bear witness. They ought soon to begin missionary work in foreign fields, for we notice in the *Indian Engineer* a description of a patent water meter with illustrations and a considerable amount of commendation. The meter is of the "inferential" type, on which a fan wheel, mounted so as to turn with the least possible friction, is rotated by the flow of the water. Unless this type of meter gives better satisfaction in foreign lands than it has in this country, it would be a blessing to those interested in water supply to have a few American meters of modern type introduced.

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Delaware River & Lancaster.—The extension of this line has been located from Springfield, Pa., via Morgantown, Churchtown, Terre Hill, Farmersville, Earlville and Landis Valley, to Lancaster, Pa., 32 miles, and construction will probably begin this season. Geo. Potts, of 40 Wall street, New York City, will have the contract.

Boston & Maine.—The town of Stoneham, Mass., has voted the $50,000 required by this company for the construction of a branch from Fells Station, Mass., to that place. The branch will be 3 miles long and will probably be built this summer.

Wilkesbarre & Western.—The extension of this road from Rohrsburg, Pa., to Orangeville, Pa., 7 miles, has been completed.

Philadelphia & Reading.—Work on the line from Bound Brook, N. J., to the Arthur Kill, 19 miles, is making good progress. Nolan Bros., of Reading, Pa., who have the contract for the first 10 miles east from Bound Brook, have 2 miles of the grading completed and the abutments and some of the piers of the bridge across the Raritan River finished. They expect to have all the masonry finished by June 1. A. J. McBean, who has the contract for the remaining 9 miles, has also begun work and is making good progress. Assistant Engineer Wm. Hunter is in charge of the work.

Deerfield Valley.—It is reported that work has begun on the extension of this road from Readsboro to Wilmington, Vt., 14 miles. The line is to be completed this season.

Greenwich & Johnsonville.—Chappell & Burke, of Rutland, Vt., are making surveys and estimates for an extension from Greenwich to Middle Falls, N. Y., 3 miles.

Bristol.—It is stated that work has been resumed on this road from Fairhaven Station to Bristol, Vt., 7 miles.

Pennsylvania.—The contract for the line from Stewart's Station to Murrysville, Pa., 7 miles, has been let to D. F. Keenan, of Philadelphia, Pa.

Baltimore & Ohio.—An agreement has been entered into between this company and the West Virginia Central & Pittsburg R. R. Co., whereby the extensions necessary to connect the two systems will be built. The extensions will be from Elkins to Bealington, W. Va., 17 miles, and from Morgantown, W. Va., to Uniontown, Pa., 33 miles. The former will be built by the West Virginia Central & Pittsburg R. R., and work is already in progress. This company also proposes to build a line from Elkins, W. Va., south to a connection with the Warm Springs Branch of the Chesapeake & Ohio R. R. The Baltimore & Ohio line from Morgantown to Uniontown has been surveyed and a small amount of grading has been done. Work is also in progress changing the Grafton & Greenbrier R. R. to standard gage. It is expected to have the work completed and the lines in operation by April 1, 1892.

Adirondack & St. Lawrence.—The work of surveys and grading is being pushed along the entire line of this New York road. The route will be from Malone, N. Y., south along the east bank of the Salmon River to St. Regis Lake, thence southwest along the west shore of Upper Saranac Lake to Tupper Lake, Little Tupper Lake, Big Moose Lake, and Jock's Lake to Poland, N. Y., about 150 miles. This portion of the line will be built under the name of the Mohawk & St. Lawrence. From Malone north to Valleyfield, P. Q., the line will be built by the Adirondack & St. Lawrence R. R. Co. in New York State, and the St. Lawrence & Adirondack R. R. Co. in Canada; and from Poland south to Herkimer, N. Y., where connection is made with the New York Central & Hudson River R. R., the Herkimer, Newport & Poland R. R. which will be changed to standard gage, will furnish the line. The contracts have been let for changing the Herkimer, Newport & Poland to standard gage and for extending it 50 miles north to Jock's Lake. From Malone south the contracts have been let for 40 miles. Grading is in progress at both ends. Grading is also in progress between Valleyfield and Malone. The road is to be laid with 70-lb. steel rails and 3,600 ties per mile.

Lancaster, Oxford & Southern.—The surveys for this road have been completed. Four miles from Quarryville, Pa., south, will be built at once and the remainder at an early date.

Philadelphia & Seashore.—Hobart & Howe, of New York City, have taken the contract for building the extension from Tuckahoe, N. J., to Sea Isle City, N. J., 10 miles. Work is already in progress.

Chicago & West Michigan.—J. J. McVean, of Grand Rapids, Mich., Chief Engineer, writes that the contract has been let to J. H. McLane & Co., of Coldwater, Mich., for constructing the proposed extension to Charlevoix and Petoskey City. The route is from Traverse City, Mich., via East Bay, Acme, Williamsburg, Barker Creek, Spencer Creek, Snowflake, Central Lake and Ellsworth, to Charlevoix and Petoskey City. The grades will be light, the line following the shores of the inland lakes, and the curves will be mostly 2° and 3°; maximum, 4°. The work is light. The principal traffic of the line will be in timber, farm produce and the tourist traffic. It is expected to have the line completed by July 1, 1892. H. F. Northrup, Traverse City, Mich., is the engineer in charge of work.

Projects and Surveys.

Erie Terminal.—Chartered in Pennsylvania to build a railway from Erie, Pa., to a connection with the Pittsburg, Shenango & Lake Erie R.R., at or near Girard Junction, Pa., a distance of about 15 miles.

Manistique & Northern.—Chartered in Michigan to build a railway from Manistique to Ishpeming, Mich.

Cleveland Belt & Terminal.—Chartered in Ohio to build a belt line transfer railway at the city of Cleveland, O. Among the incorporators are: J. W. Cassingham, M. C. Barber and H. R. Moore, all of Cleveland, O.

Anderson Belt.—Organized to build a belt line transfer railway at Anderson, Ind. W. T. Durbin and J. M. Morgan, both of Anderson, Ind., are interested.

Laurel & Roaring Point.—A bill has passed the Delaware Legislature providing for a state loan of $30,000 at 3% to aid in building the Delaware end of this road. The road is projected to run from Laurel, Del., to Tyaskin, Md., 25 miles.

Maine Shore Line.—Washington Co., Me., has voted the $650,000 of bonds asked in aid of this road.

SOUTHERN.—Existing Roads.

Norfolk & Western.—About two thirds of the grading on the Ohio extension has been finished and tracklaying is making good progress.

Chattanooga Southern.—The 1,000-ft. tunnel through Pigeon Mt. has been holed. It is expected that it will be completed and that the road will be in operation from Chattanooga, Tenn., to Gadsden, Ala., 90 miles, by June 1.

Georgia, Carolina & Northern.—Grading has been commenced on the section of this road between Athens and Atlanta, Ga. Tracklaying is being pushed between Elberton and Athens, Ga., and it is expected that the road will be in operation to the latter place in a few weeks.

Tennessee, Asheville & Coosa River.—The contracts will be let soon for building the section from Asheville, Ala., east to the Coosa River. The surveys have been completed for the section from Whitney Station to Cullman, Ala., on the Louisville & Nashville R. R.

Central R. R. of Georgia.—It is reported that this company is making the surveys for a line from some point on its Eden-Lyons Branch to Macon, Ga.

Savannah, Americus & Montgomery.—It is expected to have the grading on the extension of this road completed to Montgomery, Ala , by June 1, and the tracklaying finished by November.

Louisville & Nashville.—Grading has been begun on the belt line at Decatur, Ala.

Bishopville.—Work has been commenced on the extension of this North Carolina railway from Bishopville, N. C., north.

Carolina, Cumberland Gap & Chicago.—Geo Potts, of 40 Wall St., New York City, has the contract for grading the 34-mile extension from Edgefield, S. C., to Greenwood, S. C. About 10 miles have been located, and grading is in progress on 2 miles.

Projects and Surveys.

Norfolk, Wilmington & Charleston.—It is stated that this company will soon begin the surveys for its proposed railway from Norfolk, Va., to Charleston, S. C. John Runk, 228 Dock St., Philadelphia, Pa., Chief Engineer.

Florida, Georgia & Western.—Chartered in Florida to build a line of railway from Tallahassee to Gainesville, Fla.

Pittsburg, Washington & Southern.—This company has completed its organization under the charter recently granted by electing F. M. Jackson, of Clarksburg, W. Va., Secretary. The road is projected to run from Blacksville, W. Va., via Mannington to Clarksburg.

Charleston, Glendennin & Sutton.—Chartered in West Virginia to build a railway from Charleston to Sutton, W. Va. The incorporators are all of Charleston, W. Va.

Statesville Air Line.—It is reported that efforts are being made to organize a construction company to build the projected Statesville Air Line R. R., The road is projected to run from Spartanburg, S. C., to Salem, N. C.

Jellico, Beattyville & Ashland.—A construction company has been organized to build this railway from Jellico, Tenn., to Ashland, Ky. It is stated that nearly all of the right of way has been secured and that construction will begin this season. C. F. Davidson is President.

Nashville Construction Co.—Chartered in Tennessee to build lines of railway. Among the incorporators are T. J. Pease and Frank Morrow, both of Nashville, Ky.

Carolina, Granville & Northern.—Chief Engineer R. A. Bowie has completed the surveys for this road. It will run from Estillville, Va., via Kingsport and Greeneville, to Hot Springs, N. C., 83 miles. The maximum grade is 80 ft. per mile. It is stated that the Southern Construction Co., which has been organized to build the road, will make arrangements for beginning construction at an early date.

South Florida & Georgia Air Line.—Arrangements have been completed for building this railway from Quitman to Tampa, Fla. Contracts will be let soon for construction, rails and rolling stock. Joseph Tillman, Quitman, Fla., can give information.

Chesterfield & Lancaster.—This company has been organized in South Carolina by electing J. B. Irwin, Lancaster, S. C., President, and T. J. Redfern, Secretary.

NORTHWEST.—Existing Roads.

Missouri Pacific.—About 200 men are now at work on the proposed extension from Union to Plattsmouth, Neb., and track is being laid at the rate of 1½ miles per day.

Chicago, St. Paul, Minneapolis & Omaha.—This company is grading on the extension from Bloomfield, Neb., toward Niobrara, Neb., instead of from Hartington to Niobrara, Neb., as stated last week. It is now announced that the contracts have been let for an additional 4 miles.

St. Paul, Minneapolis & Sault Ste. Marie.—A press dispatch states that work has been resumed on the line from Aberdeen, S. Dak., to Bismarck, N. Dak., 140 miles. It is also stated that construction will soon begin on the extension from Boynton to a connection with the Aberdeen-Bismarck line.

Projects and Surveys.

Sioux City, Madison & Northern.—Chartered in South Dakota to build a line of railway from Garretson, S. Dak., to Minot, N. Dak., about 440 miles. Among the incorporators are: Chas. B. Kennedy, of Madison, S. Dak., and Craig L. Wright, of Sioux City, Ia.

Winona Terminal.—Chartered in Iowa to build a terminal railway at Winona, Minn. Among the incorporators are: R. D. Cone, Chas. Horton, and W. H. Laird.

Beardstown, Fort Madison & Sioux City.—The money necessary to defray the expenses of a preliminary survey for this projected road has been raised and work has begun.

SOUTHWEST.—Existing Roads.

Red River & Southwestern.—Grading has been completed on the first 10 miles of this road from Henrietta, Tex., west, and will, it is expected, be completed to Archer City, Tex., by June 15. The rails have been contracted for, and tracklaying will begin about June 10.

San Antonio & Aransas Pass.—Surveys are reported in progress, in the interest of this company, for a railway from Alice, Nueces Co., Tex., to San Antonio, Tex., and thence to Linares, Mexico.

St. Louis, Cape Girardeau & Fort Smith.—At a recent meeting of the stockholders the name of the Cape Girardeau & Southwestern R. R. was changed to the above. It was decided to increase the capital stock $5,000,000. The increase is for the purpose of extending the line from Hunter, Mo., to Fort Smith, and it is stated that surveys will begin at once.

Projects and Surveys.

Omaha, Kansas Central & Galveston.—A correspondent writes us as follows:

Surveys of this road are completed through Kansas and the Oklahoma territory. In Kansas it runs through the following towns and counties: Lovewell and Randall, Jewell Co.; Beloit and Saltville, Mitchell Co.; Barnard and Lincoln Center, Lincoln Co.; Ellsworth City, Ellsworth Co.; Frederick, Lyons and Alden, Rice Co.; Plevna, Reno Co.; Laredo and Rochester, Kingman Co.; Attica and Ruella, Harper Co., striking what is called the Cherokee Outlet or strip, directly south of Ruella, and thence southeasterly across the strip, crossing the Chicago, Rock Island & Pacific R. R. at the north line of Oklahoma territory. It runs thence due south to Frisco and Oklahoma City; thence it parallels the Santa Fe road to Lexington, and then follows the South Canadian River in the Pottawatomie Reservation, east to a point near the Convent of Sacred Heart, where it crosses the South Canadian River and enters the Chickasaw Nation; thence it runs south to the Stonewall coal region, and thence south 8 miles east of Tishimingo and then south in a direct line to Denison. From Denison, Tex., it runs, via Greenville, Kaufman, Fairfield, Buffalo, Madisonville, Thorpe's Mill and Houston, to Galveston. From the South Canadian River the line runs through alternate forests and prairies. The engineers have made the surveys, profiles, maps and estimates, and they report a very easy line of construction. It is contemplated to commence the construction of the road from Kansas south by June 1. The officers of the company are: Jacob Neuberger, 111 Broadway, New York city, President; C. M. Rawlings, Vice-President and General Manager, Lyons, Kan.; Valdemar Sillo, 330 East Fifty-first St., New York city, Secretary; D. M. Bell, Treasurer, Lyons, Kan.; Edward Roemer, 177 East Ninety-third St., New York city, Chief Engineer; J. B. Yates, Assistant Chief Engineer, Lyons, Kan. The general offices are at Lyons, Rice Co., Kan.

Georgetown & Granger.—Bids will be received until June 1 for grading this railway from Georgetown to Granger, Tex. Emzy Taylor, Georgetown, Tex.

ROCKY MT. AND PACIFIC—Existing Roads.

Rogue River R. R. & Improvement Co.—J. S. Howard, of Medford, Ore., Chief Engineer, writes us as follows:

This road is projected to run from Jacksonville, Ore., through Medford, Eagle Point, Fish Lake and Buck Lake, a distance of about 100 miles. The road has been completed from Jacksonville, Ore., to Medford, Ore., 5 miles, and the surveys have been finished for 17 miles additional. The contracts for this section will be let about June 15.

Atchison, Topeka & Santa Fe.—This company is making surveys for a branch up the Bear River Valley in California.

Denver & Rio Grande.—A project is on foot to build a line of railway along Texas Creek to West Cliff, Colo. It is stated that the line will be built by an independent company, and, when completed, operated by the Denver & Rio Grande R. R. Co.

Pajaro Valley.—Bids were received May 20 for building an 11-mile extension of this California railway.

Northern Pacific.—It is expected to have the line from Chehalis to South Bend, Wash., completed this season. The construction of the line has been retarded to some extent by the heavy rains of the past three weeks and the progress made was slow. The extension when completed will be 55 miles long, beginning at Chehalis. From Chehalis the route of the road follows the valley of the Chehalis River to the mouth of Rock Creek; thence to the summit of the Coast Range; thence down a small tributary to the valley of the Willapa River, and to South Bend, where the terminal facilities of the road will be located. The maximum grade on the line is 95 ft. per mile and the maximum curvature is about 10°. There is considerable bridging on the line, the Chehalis River being crossed three times, twice at Chehalis and once at Newaukam. The bridges at Chehalis have been practically completed and from that point about 3 miles of track have been laid. A considerable portion of the grading has been done from both ends of the extension. Grading on the extension has been pushed and is now nearly completed. Track is being laid.

Projects and Surveys.

Tintic Range.—Chartered in Utah to build a line of railway 65 miles long from a point on the Rio Grande Western between Provo and Spanish Forks, southwest along Utah Lake to Goshen, and thence along the Tintic range by the Homansville pass into the Tintic mining district and to Mammoth Hollow. The directors are D. C. Dodge, A. E. Welby, W. F. Colton, George Goss and Robert Harkness, all of the Rio Grande Western road.

Deep Creek.—It is reported that the contract for building this railway from Salt Lake City west to the Deep Creek mining region has been let to P. Keating, of Pittsburg, Pa., and that work will begin at once.

Boise City & Butte.—A project is on foot to build a railway from Boise City, Idaho, to Butte, Mont. Surveys are to be made at once.

Butte, Anaconda & Pacific.—A company by this name is to be chartered to build a railway from Butte to Anaconda, Mont. The surveys have been completed, and it is stated that construction will commence soon.

FOREIGN.

North Mexican Pacific.—A. M. Tenney, of Colonia Diaz, Mex., has the contract for grading 90 miles of this road from Palomas to Corralitos, Mex.

Vanegas & Rio Verde.—It is proposed to extend this railway to Tula de Tamaulpus, Mex.

Mexico.—A concession has been granted to Delfin Sanchez & Co. to build a railway from Izucar de Matamoros to Acapulco, with a branch from some point betwee the stations of Ayotla and La Compañia through Riofrio. Surveys must begin at once, construction in 10 months, and the line completed within 10 years. Alejandro Elguzabal, a member of the State Legislature of Coahuila, has been appointed an agent by the Governor of the State to make a contract for the building of a railroad from either Venadito or Jaral stations, on the Mexican International Ry., to Saltillo, on the Mexican National Ry. He is also intrusted to make arrangements in the United States for the building of a railroad from the International to Parras.

Ecuador, So. Am.—The Compañia del Ferro-Carril Nacional del Ecuador has been organized in London, England, to acquire the railways and property of the Guayaquil Railway & Public Works Co., and also a concession for railways from Chimby to Riobamba, and from Duran to Riobamba. Capital stock, $1,000,000.

CITY TRANSIT.

Electric Railways.—New lines or extensions of existing systems are reported as probable in the following places: Mobile, Ala., address Wm. M. Duncan, Nashville, Tenn.; Annapolis, Md., address H. C. Howard, South Austin, Tex.; Kanawha, W. Va., address Kanawha City Co.; Montgomery, Ala., address W. W. Marmaduke, Washington, Ind.; Pell City, Ala., address the Pell City Iron & Land Co.; Winston, N. C., address Winston-Salem Ry. & Electric Co., Chattanooga, Tenn.; Detroit, Mich , address W. H. Stevens.

Waco, Tex.—Tracklaying will soon begin on the line of the Waco Electric Ry. and Light Co. It has adopted the Thompson-Houston system.

Rome, Ga.—It is reported that the street and dummy lines will soon be run by electricity.

Atlanta, Ga.—The Metropolitan dummy lines have been purchased by the Atlanta Consolidated Street Ry. Co., which will change the motive power to electricity.

Nashville, Tenn.—Work will soon begin on the Maplewood Electrical Ry. The line will be 2½ miles long, and will be laid with 30-lb. steel rails.

Horse Railways—New lines or extensions are reported as probable in the following places: Thomasville, Ga.; San Marcos, Tex.; Denver, Col., address Denver Circuit Ry. Co.; Waxahachie, Tex., address the mayor; Galveston, Tex., address the Galveston City Ry. Co.; New York City, address the East & West Ry. Co.; Columbus, O., address Columbus Consolidated Street R. R. Co.; Geneva, N. Y., address Geneva Surface Street Ry. Co.; Rutland, Vt., address Rutland Street Ry. Co.; Houston, Tex.; Malone, N. Y.; Leesville, Mich.; Cedar Falls, Ia.; Brattleborough, Vt.; Bath, Me.; Albany, N. Y.

Waco, Tex., has passed an ordinance for $150,000 of street railway bonds.

Covington, Ky.—The Covington Street Ry. Co. will expend $150,000 in improvements if the city will relieve the company from payment of car licenses, etc.

Cable Railways.—***Baltimore, Md.***—The cable railway of the Baltimore Traction Co. is completed.

Dummy Railways.—***Lutherville, Ga.***—A dummy line is projected to run from this city to the Atlanta & West Point R. R.

Bangor, Ala.—A dummy railway is projected to run from this place to Blountsville, Ala.

Knoxville, Tenn.—The Fountain Head Ry. Co. will, it is stated, extend its line two miles.

Augusta, Ga.—The Richmond Co. Belt Line Ry. Co., has obtained a franchise for constructing a dummy railway.

Madison, Ga.—J. H. Holland has a franchise for building a dummy railway between Madison and Eutonton, Ga., 22 miles.

New Companies.—Trenton Street Ry. Co., Trenton, Mo ; capital stock, $5,000. Salina Electric Ry. Co., Salina, Kan.; capital stock, $100,000. St. Louis Electric Ry. & Power Co., St. Louis, Mo.; capital stock, $50,000. Lincoln Electric Ry. Co., Lincoln, Neb.; capital stock, $100,000. Connellsville, New Haven & Leisenring Street R. R. Co., Connellsville, Pa.; capital stock, 100,000. Fort Worth Consolidated Ry. Co., Fort Worth, Tex.; capital stock, $500,000. Albuquerque Electric Street Ry. Co., Albuquerque, N. Mex.; capital stock, $6,000; incorporators, J. Boehm, Denver, Colo.; W. B. Childers, of Albuquerque, N. Mex., and others. Central Electric Ry. Co., Sacramento, Cal ; capital stock, $500,000. Colfax Electric Ry. Co., Denver, Colo.; capital stock, $50,000. Loraine Street Ry. Co., Loraine, O.

HIGHWAYS.

New Jersey.—The $200,000 of Passaic Co. road bonds have been sold to Vermilyea & Co., of New York, at 1.53

premium, or a profit of $3,060. When existing contracts are completed, the county will have upward of 100 miles of macadamized roads radiating from Paterson as the center to the boarders of the county in all directions. The roads are macadamized only 4 ins. deep.

Pennsylvania.—The citizens and taxpayers of Springfield township will follow the example of Upper Darby, and borrow money by bonding the township to build Telford roads. Mr. P. J. Walsh, Supervisor of Roads of Upper Darby township, is at work on the new roads. The roadbed is excavated 8 to 12 ins., and filled with broken stone, rolled by a 20-ton roller. The stone used is bastard marble and trap rock, the merits of which will be compared. Telford paving is also to be tried.

Pennsylvania.—About 20 miles of telford road are to be built this year under the direction of Supervisor P. J. Walsh at Upper Darby.

North Carolina.—The Oxford & Newton Turnpike Road Co. has been incorporated by H. T. Vanhooks, W. Z. Thompson and others.

Arkansas.—The contract for macadamizing the Argenta military road has been awarded to Cook & Reinman at $6,450.

BRIDGES, TUNNELS AND CANALS.

Bridges.—*Paisley, Ont.*—Bids will be received until May 30 for constructing an iron bridge across the Saugeen River at this place. Bids will be received either for a 190 ft. single span or for two 95-ft. spans; also for masonry. Address S. McArton, Paisley, Ont.

Chester, Pa.—A plate girder bridge is talked of at this place. E. H. Roberts, City Engineer.

Columbus, O.—Bids will be received until June 11 for constructing a viaduct across the railway tracks at Leonard Ave. It will consist of two spans, one 87.65 ft. and one 159.5 ft. Bids will also be received for 9,000 perch masonry, 2,000 perch concrete, and 33,500 cu. yds. excavation. Frank J. Reinhard.

Maryland.—A bridge will be built over the Brisco Run. W. H. Shipley, Towson, Md.

Marriottsville, Md.—An iron bridge will be built over the Patapsco River at this place.

Davenport, Ia.—Plans have been prepared for a viaduct to cost $35,000. Bids will soon be asked.

WATER-WORKS.

NEW ENGLAND.

Derry, N. H.—It is reported that —— Morse will put in a windmill and lay mains to supply Mt. Washington with water from a well, the Derry Water Co. not seeming inclined to supply this section.

Barre, Vt.—It is reported that Reynolds & Thompson are laying about 2 miles of mains from a spring to supply several houses.

Brockton, Mass.—National filters will be put in.

Brookfield, Mass.—Bids are wanted until May 27 for trenching for and laying 2,000 ft. of 6-in. pipe. Address C. L. Vizard, Chairman Water Board.

Manchester, Mass.—About 20 test wells averaging 30 ft. in depth have been sunk with good results, and plans for a pumping station are now being considered.

Milford, Mass.—The directors of the company have voted to buy a new pump and boiler and enlarge the station, at a cost not to exceed $12,000. Address E. L. Wires.

New Bedford, Mass.—The specifications for the new boiler have been changed, and new bids asked. The contract formerly awarded to the Taunton Locomotive Works has finally been given to Edward Kendall & Sons, Newburyport, for $10,800.

Webster, Mass.—A petition for authority to build works is before the legislature. For a description of the present supply see MANUAL OF AMERICAN WATER-WORKS for 1889-90.

Westport, Conn.—The Westport Water Co. will take water from the West Branch of the Saugatuck River. Surveys have been made.

MIDDLE.

Batavia, N. Y.—According to press dispatches a contract with the proposed new company has not yet been made, owing to the opposition to turning the water supply over to a company.

Brooklyn, N. Y.—It is said that extensions to the mains of the Long Island Water Supply Co., in the 26th ward, are much needed and may be made.

Johnstown, N. Y.—J. J. Buchanan, Superintendent, informs us that the proposed reservoir will have a capacity of about 2,000,000 galls., and is for service while the old reservoir is being cleaned. There has been trouble with "eel grass" in the old reservoir, owing to inability to clean it.

Middletown, N. Y.—The matter of voting $40,000 in bonds for a new reservoir has been referred back to the water commissioners with the request that they include in the amount asked a sum sufficient to pay for a supply main from the proposed reservoir to the higher parts of the city.

Ocean City, N. J.—The following is from R. C. Robinson:

An ordinance granting a franchise is now before the council. The proposed company intend to try to secure a supply from artesian wells. Address E. B. Lake, Ocean City, or J. S. Doughty, 107 Market St., Philadelphia.

Rutherford, N. J.—The ordinance granting the Hackensack Water Co., of Hoboken, a franchise has passed to a third reading.

Emaus, Pa.—H. W. Janett, Secretary, informs us that the Mountain Water Co. has let contracts estimated to cost $10,000.

Evansburg, Pa.—The Evans City Water Co. has been incorporated; capital, $4,800.

Hughesville, Pa.—B. J. Welch informs us that C. E. Albright, 18 So. Broad St., Philadelphia, has charge of the construction of a water-works and electric lighting plant.

Union City, Pa.—W. Dunmeyer informs us that he has sold his works to the borough, and that the latter proposes laying mains over the whole town. The question of extensions will be decided in June. Address F. B. Camp or H. G. Sweet.

Westfield, Pa.—B. H. Walker, Elmira, N. Y., has the contract for building works; price, $19,012.

Clayton, Del.—The Clayton Water, Light & Power Co. has been incorporated; capital, $50,000.

Baltimore, Md.—The mains are being extended to the part of the city known as Waverly.

SOUTHERN.

Lynchburg, Va.—Bids are wanted for two 2,000,000 and one 3,000,000-gall. pump, with necessary boilers. Address J. B. Page, Superintendent.

Columbia, S. C.—Water bonds to the amount of $75,000 have been sold.

High Point, Belleview and Pineville, Ga.—It is reported that these places will be supplied by a company.

Macon, Ga.—The Council has passed a resolution favoring the purchase of the company's works if the present inadequate supply is not remedied.

Rome, Ga.—It is reported that Paul Cooper and others will supply East Rome from springs.

West End, Ga.—Col. Baum has presented plans according to which he offers to build works as follows: 350-ft. well, $2,000; 200,000-gall. pump, 24,000-gall. tank, with base 100 ft. above the ground, and 18,000 ft. of mains, for $20,000. The matter of boring the well has been referred to a committee.

Pell City, Ala.—The project for works has been revived. A company is proposed.

Uniontown, Ala.—J. C. Welch, Mayor, wishes proposals for $25,000 of water bonds.

Louisville, Ky.—A new stand-pipe, to take the place of the one destroyed by the tornado last year, is nearly completed. Reports state that it is 178 ft. high.

NORTH CENTRAL.

Elyria, O.—The projectors of the new supply have had the time for beginning to supply the town extended from June 1 to Dec. 1. We are informed that nothing has been done except to sink some wells, from which it is claimed an abundant supply can be obtained.

Delphi, Ind.—The following is from C. A. Brion, City Clerk:

Works will be built at once, with G. C. Morgan, Chicago, Contractor. For domestic purposes the supply will be from springs to the lower part of a water tower, and for fire protection water will be pumped from a creek to the upper part of the tower. The springs are three miles from and 32 ft. above the city. Estimated cost, $38,000. Population, 3,500.

Noblesville, Ind.—The Noblesville Water & Light Co. has been incorporated by J. R. Christian, W. N. Evans and others; capital, $50,000.

Bay City, Mich.—E. L. Dunbar, Superintendent, informs us that as soon as bonds are sold contracts will be let for a 20-in. main to be laid through the business part of the city.

Benton Harbor, Mich.—Peter English, who has a franchise, will begin to construct works at once. Pumps, stand-pipe, pipe and hydrants have been bought. The proposed supply is from driven wells.

Essex Center, Mich.—It is reported that the people have voted to build $25,000 works.

Litchfield, Ill.—Address J. C. Edwards or Eli Miller regarding the proposition to organize a local company to lay a main to Shoal Creek, city to have the right to purchase the works at any time. The city is already supplied from this source.

Peru, Ill.—Bids are wanted until June 6 for two 1,000,000-gall. compound duplex pumping engines, a water tower and the furnishing and laying of about 9 miles of mains. Address T. Gmelich, Mayor, or C. H. Ledlie, Consulting Engineer, 417 Olive St., St. Louis, Mo.

Taylorville, Ill.—About 60 tons of 4-in. pipe will be bought to replace wooden pipe.

NORTHWESTERN.

Grinnell, Ia.—Driven wells are being considered for the proposed supply.

Lyons, Ia.—S. W. Gardiner, Secretary Lyons Water-Works Co., informs us $32,000 of the company's stock is for sale.

Owatonna, Minn.—The mains will be extended.

Topeka, Kan.—The Quivera Dam & Electric Power Co. has been incorporated to build a dam and develop water power on the line of the Atchison, Topeka & Santa Fé Ry. in Wyandotte Co.

Benkleman, Neb.—J. A. Haskin, City Clerk, informs us that it is proposed to obtain a supply from irrigation ditches now under construction, if the latter are successful.

Armour, S. Dak.—Bids for 1,080 ft. of 6-in. pipe and laying same will be received until June 2, by E. R. Wanzer, Town Clerk.

Flandrau, S. Dak.—F. A. Spafford has sent the following:

The village expects to build works costing $10,000 as soon as bonds are sold. Water will be pumped from Sioux River to a stand-pipe. Population, 800.

Livingston, Mont.—An extension of the mains and 10 new hydrants have been ordered.

SOUTHWESTERN.

Cameron, Tex.—The Council are thinking of putting in works.

Dallas, Tex.—The city will issue $100,000 of water supply bonds.

Fort Worth, Tex.—It is reported that the Council has authorized the acceptance of an offer to prepare plans for extending the works, as submitted by the American Water-Works Co.; also that the same company has made a proposition to construct the works.

Rockdale, Tex.—The City Secretary informs us that works estimated to cost $40,000 are to be built at once by the Rockdale Water-Works Co. Supply, wells pumping to stand-pipe. Population, 2,000. A press dispatch states that the company has reorganized with M. P. Kelly, D. R. Copeland and others as directors.

Colorado Springs, Col.—The Brookside Water Co. has been incorporated by M. A. Foster, John Wolfe and others.

PACIFIC.

Aberdeen, Wash.—The following is from J. H. White, City Clerk:

The adopted plans for works were made by Cummings & Cook, Aberdeen. Bids are wanted until June 10 for $65,000 of water bonds.

Portland, Ore.—It is reported that if the city does not extend its mains to supply Portland Heights, the residents will put in a pump and mains. J. P. Howe is interested.

San Francisco, Cal.—Clarke's Water-Works have been incorporated; capital, $32,000.

Waterville, Wash.—The following is from R. S. Steiner;

Contracts will be let June 1 by the Waterville Improvement Co. Water will be taken from a mountain stream, 7 miles distant, and pumped to a reservoir. Estimated cost, $15,000. W. R. Ballard, Seattle, is President of the company. Address W. L. Wilson for further information. Population, 700.

CANADIAN.

Georgetown, Ont.—The people have voted to build works.

Toronto, Ont.—The new steel intake has been tested.

Kamloops and Revelstoke, B. C.—Works are to be built by an English company. The contract for pipe and pipe-laying has been awarded to N. D. McDonald, Winnipeg, Man.

ARTESIAN WELLS.

Lynchburg, Va.—Syndor & Sheppard, Richmond, have a contract for an artesian well at the West Lynchburg Hotel. It is said that this is the first attempt to secure an artesian well here.

Alexandria, La.—It is reported that a contract for two 4-in. wells, for a water supply, has been let to a New Orleans contractor.

Waukesha, Wis.—The water company proposes to sink another well.

De Smet, S. Dak.—The town has contracted with S. W. Narregang, Aberdeen, President of the Dakota Irrigation Co., for the sinking of a well.

Honey Grove, Tex.—A well is projected.

Ballard, Wash.—A company is being formed to bore for water, oil or gas.

IRRIGATION.

Phillips Co., Kan.—The Ward Irrigation Co. has bought 2,800 acres of land in the valley of the north branch of the Solomon River, between Logan and Densmore, and proposes to dam the stream and build ditches. Contracts for 6 miles of the latter have been let. A. H. Ellis, Beloit, is President. The company has an authorized capital stock of $24,000.

Gering, Neb.—E. C. Hawkins, Denver, Col., has gone to the head of the Laramie & Scott's Bluffs canal to do preliminary work. Surveys for the proposed canal are being made and it is expected that active construction will be started in June.

Kearney, Neb.—The Kearney Irrigation & Water Co. has organized with E. M. Judd, President, and S. S. St. John, Secretary. A dam, reservoir and 50 miles of canal, 50 ft. wide and 10 ft. deep, are projected. Water will be taken from the Platte River in Dawson Co. Preliminary surveys are to be made at once.

Lincoln, Neb.—The Nebraska Irrigation & Improvement Co. has been incorporated to acquire water rights for irrigating and manufacturing purposes in Kansas, Nebraska, South Dakota, Wyoming, Montana and Colorado; capital, $500,000.

Western Nebraska.—Numerous projects are on foot in this section of the state. It is reported that surveys have been made for ditches from the Republican River and tributaries at Wray, Laird, Haigler, Benkeleman, Stratton, McCook, Culbertson, Indianola and Cambridge. It is said that a company has been formed with a capital stock of $1,500,000 by I. E. Perkins, Burlington Ia., President of

the Chicago, Burlington & Quincy R. R. Co.; G. W. Holdridge, Omaha, Neb., General Manager Burlington & Missouri R. R. Co. in Nebraska, and others.

Julesburg, Col.—Contracts have been let for the Red Lion & Julesburg Canal, and work has been started under the direction of Engineer W. H. Elliott. Water will be secured from the underflow of the Platte River.

Blue Lakes, Cal.—The Blue Lakes Water Co. has sold out to Lloyd Tevis, H. D. Bacon, Henry Wadsworth and others for $300,000. The old company had about 70 miles of canals. The new company has a capital stock of $10,000,000, one-half of which has been subscribed. It is said that $6,000,000 of bonds have been subscribed for, and that the company proposes to build, at once, a 6-ft. steel conduit from the Blue Lakes into the San Joaquin Valley, supplying water for irrigating purposes and to Oakland, Sacramento, Stockton and other cities.

Modesto, Col.—The Modesto Irrigation District will receive bids until June 2 for the work on section 3 of its canal as follow: 49,800 cu. yds. of rock excavation, mostly soft sandstone; 1,000 cu. yds. loose rock, 84,000 cu. yds. earth, 10,000 cu. yds. adobe, 10,300 cu. yds. hardpan, 5,860 ft. tunnel excavation; 1,200 cu yds. rock wall, 500 cu. yds. puddle wall. The total length of the section is 25,200 ft.

San Bernardino, Cal.—The Arrowhead Reservoir Co. will make final surveys for their works north of the city; estimated cost of construction, $1,000,000.

Arizona.—The Arizona Construction Co. proposes to irrigate land on the Gila River, southeast from Phœnix. A dam will be built.

New Companies.—Dundee County Irrigation Co., Benkelman, Neb.; $5,000. Bush & Hagerman Canal Co., Hudson, Neb., $20 000; to operate in Hayes Co. West Side Ditch Co. Deer Lodge, Mont.; $28,000; incorporators, J. B. McMaster, William Williams and others. Brookside Water Co., Colorado Springs; $50,000; to construct iron pipe line and furnish water for irrigation in El Paso Co. Anna Creek Ditch Co., Linkville, Ore., $3,750. Valley Irrigation Co., Pendleton, Ore.; $5,000. Eastern Umatilla, Wild Horse, and Hudson Bay Irrigation Cos., all at Weston, Ore.; capital, first and last, $500,000, and second, $250 000; take water from Walla Walla River, Wild Horse Creek and Pine Creek, respectively, for irrigating and manufacturing purposes. Green River Canal & Irrigation Co., Ogden, Utah; $25,000.

SEWERAGE AND MUNICIPAL.

Sewers.—***New Hampshire.***—Milford will spend $5,000 for sewers.

Vermont.—Morrisville village will have surveys made for sewers.

Massachusetts.—At Haverill plans are being made for sewers in the North Parish.—Palmer has engaged J. G. Valkenburg, South Framingham, to make plans for sewers.—South Hadley Falls has ordered Engineer J. J. Kirkpatrick to make surveys for the "Hill District."—The Waltham Aldermen have ordered $150,000 sewer bonds issued for construction.

Connecticut.—At Bridgeport plans are under consideration for sewers in two recently annexed districts.

New York.—At Oneida E. E. Coon, L. Kenna, A. L. Goodrich and others have been appointed as a sewer commission to consider plans.—Warsaw is asking bids for the construction of the first section of its sewers.

New Jersey.—Kearney township wishes bids for two lines of sewers. Address Township Committee.—Weehawken has received two plans for sewers from Charles Brush, Hoboken.

Pennsylvania.—Bristol is considering sewers. C. Ph. Bassett, Newark, has made a preliminary examination.

Maryland.—At Baltimore $28,900 has been appropriated for sewers.

Alabama.—At Florence about $40,000 is to be expended for sewers, and that amount of 6% bonds are for sale.

Michigan.—Ishpeming will put in sewers.

Illinois.—At Winnetka sewers are being built by Mead & Co. on the Hubbard estate; cost, $8,000.

Wisconsin.—Hurley will issue $20,000 of bonds for sewers.

Kansas.—Lawrence will construct about 6,000 ft. of 8-in. sewers, and place laterals.

North Dakota.—Sewers will be built at Grand Forks; $50,000 was voted about a year ago.

Texas.—The Waco Council has passed an ordinance for the issuance of $40,000 sewer bonds.

Colorado.—Highland trustees have voted $40,000 for sewers.

Washington.—Fairhaven will issue $250,000 of sewerage bonds, it is reported.—Puyallup sewers are estimated to cost $45,000.

California.—At Gilroy it is reported that a person has offered to dispose of the sewage if a system is built conveying the same outside the town.—At San Francisco an intercepting sewer will be built in Point Lobos avenue.—Pomona is talking of sewers.

Idaho.—Boisé City has voted $90,000 for sewers and a city hall.

Ontario.—Belleville has under consideration a combined system, to discharge into the bay of Quinté.

Streets.—***New Jersey.***—Hackensack has voted $25,000 for street improvement.

Pennsylvania.—Mechanicsburg will spend $18,000 in improving streets.

Delaware.—The Senate has passed a bill authorizing a $500,000 street improvement loan at Wilmington.

Ohio.—Ironton is putting down fire-brick pavements.

Michigan.—Saginaw will put down three or four miles of pavement.

Wisconsin.—At Madison bids will be received by O. S. Norsman, City Clerk, until May 27, for 2,685 cu ft. of macadam paving. There will be about 4,256 cu. yds. of excavation.

ELECTRICAL.

Electric Light.—***Youngstown, O.***—An electric light plant will probably be built at this place.

Rockville, Ind.—Moore & Thurston, of Rockville, Ind., have the contract for supplying this place with 21 electric lights at $65 each.

Palatka, Fla.—The erection of an electric light plant is being discussed.

New Companies.—Monticello Electric Light Co., Monticello, Ill.; capital stock, $10,000. People's Electric Light, Heat & Power Co., Greenville, Pa.; capital stock, $25,000. Waynesboro Electric Light & Power Co.; capital stock, $15,000. Gettysburg Electric Light, Heat & Power Co., Gettysburg, Pa.; capital stock, $23,000. Yankton Gas & Electric Light Co., Yankton, S. Dak.; capital stock, $200,000. Potomac Electric Co., Washington, D. C.; capital stock, $25,000; incorporators, J. C. O'Gorman and Michael O'Donnell, Stillwater, Minn., and others. Standard Construction Co., Newport, Ky.; capital stock, $50,000.

CONTRACTING.

Reservoir.—***Meriden, Conn.***—Proposals have been received for the construction of a storage reservoir. The bidders were as follows: A, J. W. Buck & Co., Danielsonville, Conn.; B, H. Wales Lines Co., Meriden, Conn.; C, H. E. Stanton, Huntington, Mass.:

	A	B	C
Earth in foundations, 8,500 cu. yds.	$ .40	$ .50	$ .44
Puddle wall, 8,000 cu. yds.	.58	.60	.49
Embankment, 35,600 cu. yds.	.32	.49	.44
Rock, 500 cu. yds.	3.50	3.50	1.50
Rubble masonry, 550 cu. yds.	6.00	5.25	9.90
Concrete masonry, 30 cu. yds.	6.00	6.00	6.00
Paving, 2,000 cu. yds.	3.00	2.25	2.40
Building road	1,110.00	1,900.00	1,200.00
Cutting wood, 100 cords	1.50	200.00	1.50
Clearing basin, 1.600 sq. yds.	1.12½	1.90	3.00
Gate house, bridge and screens	1,000 00	750.00	1,000.00
Total	37,422	43,726	43,809

Street Work.—***Avondale, O.***—The following proposals have been received for brick paving on Main Ave.: Patrick Gleason, $4 per sq. yd. for concrete, 40 cts. per cu. yd for excavation, $2.85 per sq. yd, for paving; Powers & Sullivan, $4, 40 cts., $1.95 with Porter or Canton brick. Ohio Co., $3.50, 33 cts., $1.82 with Canton, $1.70 with Porter, or $1.80 with New Lisbon brick. James Holmes, $3.75, 15 cts., $1.45 with Porter.

Lead.—***Portland, Ore.***—The Water Committee has awarded a contract to the Pacific Metal Co. for 50,000 lbs. of pig lead, at $4.45 per 100 lbs.

Canal Excavation.—***Tuscola, Ill.***—The contract for the extension of the drainage canal has been awarded to J. E. Rogers, at 8½ cts. per yd. It will be 7 miles long, 40 ft. wide, and 7 to 10 ft. deep.

Sewers—***Everett, Mass.***—The contract for brick sewer on Main street has been awarded to A. W. Bryne: 185 ft. of 24 × 26 ins., 8-in. wall, $3.25; 400 ft of 40 × 42 ins., 8 in. wall, $4.50; 3,400 ft. of 30 × 45, 8-in. wall, $4.75; 1,280 ft. of 20 × 30 ins., 4-in. wall, $2.25. Mr. J. R. Carr, of Chelsea, Mass., is the Engineer.

Milwaukee, Wis.—Contracts for pipe sewers have been awarded by the Board of Public Works at $1.39 to $1.60 per ft. for 12-in., $1.50 to $2 for 15-in., and $2 to $3 for 18-in.

Dredging.—The only proposal received May 11, by Capt. W. M. Black, U. S. Engineer Office, St Augustine, Fla., for dredging in Charlotte Harbor Tampa Bay and Hillsboro Bay, was from the Alabama Dredging and Jetty Co., Mobile, Ala., at 25 cts. per cu. yd.

PROPOSALS OPEN.

Street Work.—***Brooklyn, N. Y.***—Grading, paving and sidewalks. J. P. Adams, Commissioner City Works. May 29 and later.

Columbus, O.—Grading and constructing thereon an asphalt, stone block, Hayden block, Hallwood block, fire-clay or hard-burned brick pavement and setting 5-in. curb of Berea or Fulton stone on 10 streets. Also constructing sidewalks. Board Public Works, May 28.

Norwood, O.—Grading, macadamizing, curbing and guttering Floral and Cameron Aves. W. E. Wichgar, Clerk. May 30 and June 15.

West Chicago, Ill.—Common filling, stone curbing, cedar-block paving, granolithic sidewalk, trees, lamp-posts. Cuthbert McArthur, Secretary W. Chicago Park Commissioners, May 26.

Clinton, Ia.—Brick pavement, 35,000 sq. yds. C. P. Chase, City Engineer. June 9.

Newark, N. J.—Fifteen miles pipe sewer. Francis Marvin, President Sewer Commissioners. May 29.

Washington, D. C.—Sewers and receiving basins. Commissioner. June 2.

North Yakima, Wash.—Sewers. F. M. Spain, City Clerk. June 15.

Cement.—***Washington, D. C.***—Cement for the District of Columbia for 1892. Commissioners. June 8.

Excavator and Hoisting Engine.—Address Capt. C. Shaler, P. O. Box 1449, New York. June 10.

MANUFACTURING AND TECHNICAL.

Locomotives.—The Baldwin Locomotive Works, of Philadelphia, Pa., have built 2 passenger engines for the Denver & Rio Grande, and 20 10-wheel passenger and freight engines for the New York, Lake Erie & Western. The Rhode Island Locomotive Works, of Providence, R. I., are building 6 compound engines for the Mexican Central. The Lima Machine Co., of Lima, O., has built a Shay geared engine for the Montana Union, having 12 wheels, all driven by gearing, and weighing 176,000 lbs. in working order. A locomotive for a logging road of 3-ft. gage is wanted by Laurence & Thornton, Doyline, La.

Cars.—The Elliott Car Works, of Gadsden, Ala., has built 20 ventilated fruit cars for the Alabama Great Southern. The Pullman Palace Car Co., of Chicago, Ill., has built 2 elaborate cars for the Atchison, Topeka & Santa Fé; they are 70 ft. long. The Ohio Falls Car Co., of Jeffersonville, Ind., is building 6 passenger cars for the Newport News & Mississippi Valley. The Harvey Steel Car Co. is building stock cars and 60,000-lb. ore cars for the Illinois Central. The John Stephenson Co., of New York, will build its new street car works near Larchmont, on the New York, New Haven & Hartford; electric and cable cars will be a specialty. The Birmingham Railway & Electric Co., of Birmingham, Ala., wants to purchase cars. The United States Rolling Stock Co., of Anniston, Ala., has an order for 100 freight cars.

Track Crossing.—The Fontaine Crossing Co. has established works at Detroit, Mich., for the manufacture of crossings, interlocking plant and signals.

Railway Station.—A new station is to be built at Manchester, N. H., by the Boston & Maine.

Indurated Fiber.—The Engineering Equipment Co., of New York, has the exclusive agency for the underground conduit pipes manufacured by the Indurated Fiber Co. at Mechanicsville, N. Y.

Iron Buildings.—The new buildings for the Baltimore Electric Refining Co., of Baltimore, Md., will be entirely of iron, and built by the Berlin Iron Bridge Co., of East Berlin, Conn. The rolling mill will be 56 × 180 ft., the refining building 130 × 80 ft., and the boiler house 49 × 50 ft.

Companies.—Illinois Judson Power Co., of Chicago, Ill., to operate the Judson system for traction and power; George L. Pfeiffer, George W. Ross and W. Barry; $1,000,000. Metal Construction Co., of Chicago, Ill.; W. R. Northway, M. Randolph and I. T. Dyer; $200,000. Municipal Construction Co., of Peoria, Ill.; J. T. King, G. H. Lucas and E. W. Wilson; $100,000. Scully Castle Co., of Chicago, Ill., to manufacture railway supplies; Joseph Cummins, L. H. Foster and A. W. McClellan; $25,000. Fort Smith Paving Brick & Fire Clay Co., of Fort Smith, Ark.; W. A. Doyle. Parkersburg Bridge Co., of Parkersburg, W. Va., to build a bridge 1 000 ft. long across the Little Kanawha River; Wm. Bentley, J. S. Camden and J. H. Fischer; $500,000. Nashville Construction Co., Nashville, Tenn.; T. J. Pease and others. Paterson Electrical Manufacturing Co.; R. Eastwood, Paterson; $100,000. McLean Engineering Co., Hoboken, N. J., to install electric motors and other engineering work; E. McLean, Brooklyn; $30,000.

Metal Market Prices.—***Rails.***—New York: $30.75; old rails, $24.50 for iron and $17 for steel. Pittsburg: $30; old rails, $24 for iron and $17.25 to $17.75 for steel. Chicago: $31; old rails, $23 to $23.25 for iron and $14.50 to $17 for steel.

Track Materials.—New York: steel angle bars, 1.7 to 1.75 cts.; spikes, $1.9 to $1.95; track bolts, 2.60 cts with square, and 2.75 cts. with hexagon nuts. Pittsburg: splice bars, 1.85 to 1.95 cts. for iron or steel; iron or steel spikes, 2.05 cts.; iron track bolts, 2.8 cts. with square, and 2.9 cts. with hexagon nuts. Chicago: splice bars, 1.85 to 1.9 cts. for iron, 2 to 2.05 for steel; spikes, 2 cts.; track bolts, 2.8 to 2.9 cts. with hexagon nuts.

Foundry Pig Iron.—New York: $14 to $16. Pittsburg: $14 to $15. Chicago: $14.50 to $16.

Pipe.—Cast iron, $25 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 55 and 45 per cent. on black and galvanized butt-welded; 65 and 52½ on black and galvanized lap-welded. Casing, 55 per cent.

Lead.—Chicago: 4.5 cts.; St. Louis: 4 cts.

Structural Material.—New York: beams, 3.1 cts.; channels, 3.1 cts.; angles, 1.95 to 2.1 cts.; tees, 2.45 to 2.75 cts.; sheared iron plates, 1.95 to 2.25 cts.; steel plates, 2 to 2.15 cts. for tank, 2.3 to 2.6 cts. for shell, 2.5 to 2.7 cts. for flange, 3.75 to 4.25 cts. for firebox. Pittsburg: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2.05 cts.; tees, 2.65 cts.; universal iron mill plates, 2.1 cts.; sheared steel bridge plates, 2.3 cts.; refined bars, 1.85 to 1.9 cts.; steel plates, 2.1 to 2.15 cts. for tank, 2.45 to 2.5 cts. for shell, 2.7 cts. for flange, 3.9 to 4.25 cts. for firebox. Chicago: beams, 3.2 cts.; channels, 3.2 cts.; angles, 2.25 to 2.3 cts.; tees, 2.6 to 2.7 cts.; universal plates, 2.3 to 2.4 cts.; sheared plates, 2.5 to 2.6 cts. for iron and 2.6 to 2.7 cts. for steel; steel plates, 2.6 to 2.7 cts. for tank, 3.25 cts. for shell, 3.5 cts. for flange, 4.25 to 5.5 cts. for firebox; boiler rivets, 4 to 4.25 cts.